(2)

ESL-TR-88-81

LONG-TERM REFLECTIVE CRACK MONITORING OF ASPHALT CONCRETE OVERLAYS

R.A. BENTSEN

USAEWES
GEOTECHNICAL LABORATORY
P. O. BOX 631
VICKSBURG MS 39181-0631

JUNE 1989

FINAL REPORT

APRIL 1988 — SEPTEMBER 1988

AFESC

AIR FORCE ENGINEERING & SERVICES CENTER
ENGINEERING & SERVICES LABORATORY
TYNDALL AIR FORCE BASE, FLORIDA

Unclassified
SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION Unclassified	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY 2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	3 DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution unlimited.
4. PERFORMING ORGANIZATION REPORT NUMBER(S)	5. MONITORING ORGANIZATION REPORT NUMBER(S) ESL-TR-88-81
6a. NAME OF PERFORMING ORGANIZATION USAEWES Geotechnical Laboratory 6b. OFFICE SYMBOL (If applicable) CEWES-GP-T	7a. NAME OF MONITORING ORGANIZATION Air Force Engineering and Services Center (RDCP)
6c. ADDRESS (City, State, and ZIP Code) PO Box 631 Vicksburg, MS 39181-0631	7b. ADDRESS (City, State, and ZIP Code) HQ, AFESC/RDCP Tyndall AFB, FL 32403-6001
8a. NAME OF FUNDING/SPONSORING ORGANIZATION Air Force Engineering and Services Center 8b. OFFICE SYMBOL (If applicable) RDCP	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER MIPR N 88-45
8c. ADDRESS (City, State, and ZIP Code) HQ, AFESC/RDCP Tyndall AFB, FL 32403-6001	10 SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. | PROJECT NO. | TASK NO. | WORK UNIT ACCESSION NO.

11. TITLE (Include Security Classification)

Long-Term Reflective Crack Monitoring of Asphalt Concrete Overlays

12. PERSONAL AUTHOR(S)

Bentsen, Ross A.

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Final report	FROM 4/88 TO 9/88	June 1989	60

16. SUPPLEMENTARY NOTATION

Availability of this report is specified on reverse of front cover

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)	
FIELD	GROUP	SUB-GROUP	Asphalt covered	Interlayers
			Asphalt-rubber	Overlays
			Fabrics. (AU)	Reflective cracking

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

A test section was constructed at Peterson AFB, Colorado, in October 1985 to study the ability of five different treatments to reduce reflective cracking in asphalt overlays. A summary of the cracking is given, and the performance of the treatments is evaluated. The saw cutting of the asphalt concrete overlay surface over the portland cement concrete joint is effective in reducing reflective cracking. The other four treatments are showing worse performance than the control sections. Variables introduced into the study have decreased the integrity of the results, and further survey and evaluations may not yield significant information.

A test section was constructed at Maxwell AFB, Alabama, in July 1988 to study the ability of six different fabric interlayers to reduce reflective cracking in asphalt overlays on a nontrafficked pavement. The design and construction details of the test section are presented. Keywords: Rubber,)

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION Unclassified
22a. NAME OF RESPONSIBLE INDIVIDUAL Capt Michael J. Coats	22b. TELEPHONE (Include Area Code) (904)283-6322 22c. OFFICE SYMBOL HQ AFESC/RDCP

DD Form 1473, JUN 86 — Previous editions are obsolete. — SECURITY CLASSIFICATION OF THIS PAGE

Unclassified

(The reverse of this page is blank.)

PREFACE

This report was prepared by the Geotechnical Laboratory (GL), US Army Engineer Waterways Experiment Station (WES), under Military Interdepartmental Purchase Request N88-45, sponsored by the Air Force Engineering and Services Center, Engineering and Services Laboratory (AFESC/RD), Tyndall Air Force Base, Florida. The AFESC/RD project officer was Capt Michael J. Coats.

This study, performed from April to September 1988, was conducted under the general supervision of Dr. W. F. Marcuson III, Chief, GL; Messrs. H. H. Ulery, Jr., Chief, Pavement Systems Division (PSD), GL; and J. W. Hall, Jr., Chief, Engineering Investigations, Testing and Validation Group, PSD, GL. Mr. R. W. Grau, Chief, Prototype Testing and Evaluation Unit provided direct supervision. The field testing was performed by Messrs. R. A. Bentson, R. C. Ahlrich, and D. D. Mathews, PSD, GL. This report was written by Mr. Bentson.

Col Dwayne G. Lee was the Commander and Director of WES. Dr. Robert W. Whalin is the Technical Director.

This report has been reviewed by the Public Affairs Office and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nationals.

This technical report has been reviewed and is approved for publication.

Michael J. Coats

MICHAEL J. COATS, Capt, USAF
Project Officer

Charles W. Manzione

CHARLES W. MANZIONE, Capt, USAF
Chief, Airbase Operating Surfaces Branch

Robert J. Majka

ROBERT J. MAJKA, Lt Col, USAF
Chief, Engineering Research Division

LAWRENCE D. HOKANSON, Colonel, USAF
Director, Engineering and Services Laboratory

(The reverse of this page is blank.)

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF FIGURES

(Continued)

LIST OF FIGURES
(Concluded)

LIST OF TABLES

(The reverse of this page is blank.)

SECTION I

INTRODUCTION

A. OBJECTIVE

The objective of this study was to evaluate the effectiveness of different treatments for reducing reflection cracking in asphalt concrete (AC) placed over portland cement concrete (PCC), AC, and soil cement surfaces.

B. BACKGROUND

The United States Air Force (USAF) constructed two test sections to compare the effectiveness of different materials and construction methods in reducing reflection cracking in AC pavements. A test section was constructed in October 1985 at Peterson AFB, Colorado. It is subject to medium-sized aircraft traffic such as C-130, C-141, and KC-135. Five different treatments and a control section were constructed over two base pavements (a PCC pavement and a soil cement base). A preconstruction cracking survey was performed against which subsequent reflective cracking surveys are compared to evaluate the effectiveness of the reflection cracking treatments. Reflective cracking survey and Evaluations 1 and 2 were performed in July 1986 and June 1987, respectively (Reference 1).

A test section was constructed in July 1988 at Maxwell AFB, Alabama, on an abandoned runway that will receive no traffic. Six different treatments and a control section were constructed over 12 inches of AC and asphalt macadam over a broken PCC base.

C. SCOPE

This report summarizes reflective cracking survey and Evaluation 3 performed in April 1988 on the test section at Peterson AFB, as well as the preconstruction cracking survey and construction specifications for the Maxwell AFB test section. The surface cracking at Peterson AFB was measured and mapped to scale, and observations were made as to the effectiveness of the various treatments. Cracking as a function of AC thickness is

discussed. The current pavement condition index (PCI) of each treatment section was also determined in accordance with AFR 93-5 (Reference 2).

For the reader's convenience, tables and figures are placed at the end of this report.

SECTION II

PETERSON AFB, COLORADO,

TEST SECTION EVALUATION 3

A. BACKGROUND

A pavement test section was constructed at Peterson AFB, Colorado, in October 1985 to evaluate the performance of various materials used to reduce reflective cracking in AC overlays. The test section is a 70-foot-wide by approximately 4,650-foot-long strip situated between the Peterson AFB apron and the adjacent taxiway. Two base types were overlaid in this study (a conventional PCC pavement and a soil cement base course).

The study variables include a control section and five treatments to evaluate their effectiveness in reducing reflective cracking. The material and construction specifications for the test section are given in Reference 1. The five treatments are as follows:

1. Asphalt-rubber stress-absorbing membrane interlayer (SAMI)
2. Polymer modified asphalt-rubber stress-absorbing membrane interlayer
3. Fabric interlayer
4. Rubber-filled AC (RFAC)
5. Conventional AC with joints sawed at the same location as the underlying PCC joints and cracks (not used over the soil cement base)

Each of the study variables was replicated twice in the test section construction which yielded requirements of 12 PCC base sections and 10 soil cement base sections. The length of each base type and the requirements determined by the study variables produced twelve 275-foot-long sections on the PCC base and ten 135-foot-long sections on the soil cement base (Figure 1). The PCC base sections are located from Stations 0+00 to 33+00 of the test section, and the soil cement base sections are located from Stations 33+00 to 46+50. The construction of the test section involved milling off the old AC surface and constructing the treatment on its respective section. Figure 1 also gives the pavement cross section that was

controlled by the existing thicknesses of the adjacent pavement and drainage requirements.

B. REFLECTIVE CRACKING SURVEY AND PERFORMANCE EVALUATION

1. Previous Survey and Evaluations

A preconstruction cracking survey of the old AC surface was performed in 1985 before its removal (Reference 1). Each 275-foot-long PCC base section was divided into eleven 25-foot subdivisions, and each soil cement base section was divided into four 25-foot subdivisions and one 35-foot subdivision. The surface cracking was then mapped to scale in each of the subdivisions. At the time of the preconstruction survey, the AC over the PCC base sections exhibited reflective cracking of the PCC joints and cracks in the slabs which were summarized as linear feet of cracking per subdivision. The AC surface cracking in the soil cement base sections was random alligator cracking which was summarized as square feet per subdivision. Subsequent reflective cracking surveys are compared to this survey by determining a percentage of cracking relative to the preconstruction cracking. Reflective cracking survey and Evaluations 1 and 2 were performed in July 1986 and June 1987, respectively (Reference 1). The data from reflective cracking Survey 3 will also be evaluated by comparing the present cracking to the preconstruction cracking. However, as indicated in a later discussion concerning the adjustment of the preconstruction survey data and the removal of the asphalt paving joint cracking from the reflective cracking count, comparison of the data from Surveys 1 and 2 and Survey 3 is not possible.

An investigation of the preconstruction cracking survey revealed that PCC base Sections 2, 3, 6, 8, and 12 had large areas of patching and overlay repair (Table 1). Their placement, which was not related to this project, was probably made because of extensive cracking; and, except for Section 12, the repairs had no cracking in them. However, there is now reflective cracking in these areas of the test section. Since no information is available on the amount of cracking which had existed before the patch or overlay placement, these patched areas could not be used in the

evaluation of the treatments in the PCC base section. The cracking present in the patching of Section 12, which amounted to 255 linear feet, will be subtracted from the preconstruction cracking count, and the cracking observed in reflective cracking Survey 3 in these previously patched areas will not be included. When considering the adjusted preconstruction cracking divided by the nonpatched section area (Column 5 of Table 1), the coefficient of variation (COV) of this data (12.9 percent) indicates that the amount of cracking before test section construction was fairly uniform over the nonpatched pavement. The preconstruction survey indicated no significant areas of patching in the soil cement base sections.

2. Reflective Cracking Survey 3

A third reflective cracking survey of the Peterson AFB test sections was performed in April 1988. As in the previous surveys, the surface cracking in each test section subdivision was mapped to scale.

Previously located section landmarks and measurements made in relation to the distinctly surfaced RFAC sections indicate that the soil cement test sections are not constructed in the exact layout described in the construction specifications. Some variations exist in the 135-foot design length. Table 2 gives the length of each of the soil cement sections as they were recorded in the third reflective cracking survey. Because of these variations, adjustments must be made to the preconstruction cracking totals so that comparisons can be made between the current cracking and the preconstruction cracking. These adjustments were made by adding or subtracting cracking totals from the adjacent subdivision, as required by the revised test section lengths. For example, Test Section 13 is actually 150 feet long, so the cracking from the first 15 feet of the first subdivision of Section 14 was added to the total for Section 13. Section 14 was readjusted by applying the cracking from the first 15 feet of the first subdivision of Section 15. This procedure was performed throughout the soil cement base test sections. The adjusted preconstruction totals for these sections are also given in Table 2. A COV of the preconstruction cracking can be determined by normalizing these adjusted totals to a 135-foot section

length. These data are shown in Table 2, and the resultant COV is 12.3 percent.

The cracking in the soil cement base sections in the preconstruction survey was characterized by large areas measured in square footage, and the cracking in the first two reflective cracking surveys was measured in linear feet. Currently, most of the reflective cracking is still linear, but the density of cracking has increased in a few areas. The cracking in these areas is more measurable in square feet. If both linear and area cracking measurements were used in the evaluation, it would be difficult to compare the data to the preconstruction cracking. Therefore, the few areas of cracking measured in square feet will be converted to linear cracking. This conversion is explained and performed in the soil cement base portion of the report.

3. Reflective Cracking Evaluation 3

The evaluation of reflective cracking Survey 3 involves determining the performance of each treatment on the two base types using the current cracking relative to the preconstruction cracking. As in the previous evaluations, an analysis of variance (ANOVA) was calculated on the total cracking data to determine if any significant differences exist between the treatments. Additionally, a condition survey was performed to determine the PCI for each treatment, and the amount of cracking as a function of the thickness of the AC overlay was determined.

One problem arising with the third reflective cracking survey and evaluation is how to consider the AC overlay paving lane joints and the cracking that exists along them. The sawed sections showed seven 10-foot PCC slab widths within the 70-foot width of the PCC test section. There were six AC overlay paving lanes along the length of the entire test section. In many areas, these paving joints were cracked along the full length (Figure 2), and the only controlling factor of whether they were cracked or not appeared to be the AC density at the paving joint. Figure 3 shows a paving joint as it comes through a sawed section.

One possible reason these cracks exist is that there is no bond between the pavement base and the AC overlay. The movement in the base

causes a reflective crack not directly above the crack but at a relatively close weak point in the AC surface. In this case the weak point is the AC overlay paving joint. Another possibility is that the crack formed was caused by expansion and contraction in the AC surface. If it was assumed that there was slippage at the boundary between the pavement base and the AC overlay, slippage cracks caused by the combination of the loss of bond and the aircraft traffic would appear. However, no cracking of this type exists in the test section; therefore, it is concluded that the cracking is caused by the thermal expansion and contraction of the AC surface. Since the scope of this study is to determine the effectiveness of various treatments against reflective cracking, the cracking along the asphalt paving joints in both base type sections will be ignored when any conclusions are drawn.

a. PCC Base Test Sections

The cracking in each PCC base section is summarized in Table 3. The summary for each subdivision includes the stationing of the subdivision, the reflective cracking, the paving joint cracking, the reflective cracking located in patched areas, and the section totals. The paving joint cracking and the cracking in the patched areas are not considered in the evaluation. Table 4 compares the data to the adjusted preconstruction cracking. Figures 4 through 25 give typical views of the cracking in the PCC base sections.

(1) Treatment Performance. Figure 26 presents the total cracking from the third reflective cracking survey for each PCC base section. The top graph shows the data ordered by section, and the bottom graph shows the data ordered from greatest to least by the amount of cracking.

Performance of the treatments can be evaluated by comparing the present cracking relative to the preconstruction cracking. Figure 27 shows the reflective cracking from the third survey as a percentage of the preconstruction cracking, again with the top graph ordered by section and the bottom graph ordered from greatest to least. The two sawed sections are showing better performance than the other treatments and the control sections. The rubber-filled asphalt sections, the fabric sections, and the

modified rubber-asphalt section show varying degrees of performance that are worse than the control sections. The asphalt-rubber sections are performing about the same as the control sections. The COV of the relative cracking data of 57.7 percent given in Table 4 indicates the degree of variation in the current reflective cracking relative to the preconstruction survey.

A section using a reflective crack retardant should, at worst, exhibit performance as good as one built with no treatment. Except for the sawed sections, the treatment sections are performing at the same level or worse than the control. The rubber-filled AC appears not to be as effective in reducing reflective cracking as the conventional AC, and this may truly be the case. However, the treatments placed along with the conventional AC overlay show a negative benefit for their installation. Various possibilities exist for the worst performance. The placement of the fabric on the base is critical in its performance. Wrinkles in the fabric can cause cracks to form in the AC overlay (Reference 3). Section 3 had over 60 percent patching in the preconstruction surface. The reduction in the effective size of Section 3 may introduce error into the data. Base PCC slabs that exhibit differential movement under load cause cracks to reflect more quickly (Reference 4). The selection of the comparison to preconstruction cracking for evaluating the treatments might cause problems. Reflective cracking studies, especially with overlays of PCC, are often evaluated by comparing the reflective cracking to joints and cracks that exist in the base pavement (Reference 3). Some cracks that did not reflect through the AC surface at the preconstruction survey may be reflecting through the new pavement. Any or all of these scenarios may be the cause for the treatments exhibiting negative benefit.

(2) Analysis of Variance. The results of the ANOVA on the total reflective cracking in the PCC base sections are given in Table 5. Since the areas which had been patched are not considered in the test section evaluation, the ANOVA was performed on the reflective cracking as a function of the area of the test section which had not been patched. The results show that reflective cracking is not uniform throughout the section. Since extensive changes have been made in the preconstruction survey data because

of the patching, no statistical significance can be applied to the reflective cracking data relative to the preconstruction cracking.

(3) Condition Survey. The PCI of each PCC base section is given in Table 6. The PCI is given both with and without consideration of the AC paving joint cracks. The PCI procedure differentiates between reflective cracks that occur at a PCC joint and those that are caused by cracks in the underlying PCC slab. Reflective cracks that do not occur at a PCC joint are considered longitudinal and transverse cracks. The AC paving joint cracks are also considered as longitudinal and transverse cracking in determining the PCI. The PCI of a PCC base section drops an average of about six points when considering the AC paving joint cracks in the calculation.

(4) Cracking as a Function of Thickness. The design of the test section varies in thickness to accommodate drainage and the adjoining apron and taxiway pavement. Figure 1 shows that the thickness of the section varies from 3 inches at the taxiway to about 1.75 inches at the drainage swale and up to 7 inches at the apron. A thicker overlay will often reduce the amount of reflective cracking (Reference 3). To determine if the reflective cracking varies as a function of the overlay thickness, the test section was divided into thick and thin areas of overlay thickness using 3 inches as the dividing thickness. The 3-inch division line is located 28 feet from the apron and 42 feet from the taxiway. These dimensions place 40 percent of the pavement in the thick pavement area and 60 percent in the thin pavement area.

Table 7 lists the reflective cracking in each section as a function of the thickness of the AC overlay. The last column in Table 7 gives the amount of reflective cracking in the thick section as a percentage of the total reflective cracking. Figure 28 shows this same information graphically. If there were no difference in the amount of reflective cracking in the thick and thin pavement areas, then the values in the last column of Table 7 would be 40 percent. Seven of the 12 sections have percentages within 10 percent of or greater than 40 percent. The other five sections, with values between 5 and 28 percent, indicate that the cracking is occurring proportionately more in the thin section.

These data do not conclusively show that the reflective cracking occurs more in the thin pavement than in the thick. However, most previous comparisons were made between independent test sections utilizing a uniform thickness over the length and width. These compare data from within the same pavement surface with no stress relief mechanism between the thin and thick pavement. A crack that starts in the thinner portion may be propagating into the thicker portion because of the continuation of the pavement surface. The effect of thickness on reflective cracking should be proven with separate pavement sections, not a continuous pavement surface.

(5) Conclusions

(a) The COV of the performance data compared to the COV of the preconstruction data (57.7 to 12.9 percent) and the ANOVA of the total reflective cracking data indicate that the cracking is not uniform over the entire sections.

(b) The sawed sections are showing good performance in retarding reflective cracking.

(c) The rubber-filled AC sections are showing performance worse than the control AC sections.

(d) The fabric and modified asphalt-rubber sections are showing worse performance than the control sections. Because they were constructed using the same AC surface as the control sections, they should at least be performing at the same level.

(e) The test section is not useful in determining the effect of overlay thickness on reflective cracking.

b. Soil Cement Base Test Sections

The cracking in each soil cement base section is summarized in Table 8. The summary for each subdivision gives the stationing for each subdivision and the reflective cracking as measured in linear feet and square feet for each subdivision as well as the paving joint cracking and the section totals. Figures 29 through 42 give typical views of the cracking seen in the soil cement base sections.

As shown in Table 8, some areas of reflective cracking in the soil cement base test sections have a higher density of reflective cracking and can be better measured in square feet. These areas, more characteristic of block cracking than alligator cracking, were not very large and are not found in all of the soil cement base sections. The combination of linear and block cracking leads to problems in the evaluation when trying to compare both types of crack measurement to the preconstruction cracking which was measured in square feet. Therefore, some of the block cracking areas were also measured in linear feet to develop a correlation between the block and the linear cracking and allow for the conversion of the block cracking to linear cracking. The data used in the development of this correlation are given in Table 9. Thirteen of the 25 areas which exhibited block cracking were also measured for linear cracking, and the ratio of linear feet to square feet is given in the third column. The COV of 44.0 percent indicates the high variability between the ratios. Based on these data, the ratio of 1.75 feet of linear cracking for every square foot of cracking will be used to convert the block reflective cracking to linear reflective cracking. This highly subjective selection is made because it is close to the mean, and six of the calculated values are greater than and seven are less than this ratio.

(1) Treatment Performance. Table 10 gives the total reflective cracking in each section expressed as linear cracking. These data are the linear reflective cracking added to any converted block cracking. Since all of the soil cement base sections were not 135 feet long, the total reflective cracking was normalized to a 135-foot section so the data comparisons could be made. As presented in Table 10, the COV of the normalized reflective cracking is 31.0 percent. Figure 43 presents the normalized reflective cracking from the third survey for each soil cement base section. The top graph shows the data ordered by section, and the bottom graph shows the reflective cracking data sorted from greatest to least. One of the control sections exhibits about 40 percent more reflective cracking than any of the other sections.

Since the preconstruction cracking was measured in square feet and the reflective cracking from this survey is analyzed in linear

feet, the comparison of the data is not a percent but a ratio which has been expressed as a percent. These ratios, which indicate the relative performance of each treatment, are given in Table 10 and illustrated in Figure 44. The top graph in Figure 44 shows the performance data ordered by section, and the bottom graph shows the performance data sorted from greatest to least. This comparison still shows one of the control sections performing the worst, and the other control section is next to the best. The COV of this performance data is 26.1 percent.

The COV of the performance data indicates that the variation between the soil cement base sections is smaller than the variation between the PCC base sections. Depending on which control section the performance data are compared to, positive or negative benefit is being achieved by the placement of the treatments. The same reasons given in the evaluation of the PCC base sections apply here if the benefit is negative. Also, the conversion of block cracking to linear cracking may be adding some uncertainty to the data. Of the six sections having block cracking, five of these (Sections 13, 17, 19, 20, and 21) are among those showing the worst performance, and Section 19 has the most block cracking. If the conversion ratio from block cracking to linear cracking is too high, then the poor performance shown by these sections may not be correct.

(2) Analysis of Variance. The results of the ANOVA on the total reflective cracking in the soil cement base sections are given in Table 11. Since the soil cement sections are not of uniform length, the ANOVA was performed on the reflective cracking as a function of the area of the section. The results show that the reflective cracking is not uniform throughout the test section. Although adjustments in the preconstruction cracking totals could be made for each treatment section, individual adjustments in each subdivision within the section would introduce too much error in the preconstruction cracking data to retain its statistical significance. Therefore, no ANOVA can be calculated for the reflective cracking data relative to the preconstruction cracking.

(3) Condition Survey. The PCI of each soil cement base section is given in Table 12. The PCI is given both with and without consideration

of the AC paving joint cracks. The cracking in the soil_cement section is not considered reflective in the PCI procedure. Reflective cracks must be underlain by PCC pavement. The areas measured in square feet are considered block cracking, and the linear cracking is considered longitudinal and transverse cracking. The PCI decreases about an average of seven points when including the paving joint cracking.

(4) Cracking as a Function of Thickness. Table 13 lists the reflective cracking in each section as a function of the AC overlay thickness. The reflective cracking in these sections has been expressed as linear cracking. The last column in Table 13 gives the amount of reflective cracking in the thick section as a percentage of the total cracking. Only 1 of the 12 sections has a percentage less than 40 percent, indicating that the reflective cracking is not occurring more in the thin pavement than in the thick pavement. However, the preconstruction survey indicates that most of the cracking in the soil cement sections occurred in the 50 feet of pavement closest to the apron, which is the location of the thicker pavement.

(5) Conclusions

(a) The COV of the performance data compared to the COV of the preconstruction data (31.0 to 12.3 percent) and the ANOVA of the total cracking data indicate that the reflective cracking is not uniform over the entire section.

(b) The control sections are exhibiting both poor and good performance, and the performance of the treatments is spread out between the two control sections.

(c) The conversion of block cracking to linear cracking may be adding uncertainty to the data.

4. Recommendations

Based on the results of this evaluation, the sawing of the AC overlay over the underlying PCC can be recommended for use in reducing reflective cracking. Aside from the sawed sections, the data from

reflective cracking survey and Evaluation 3 are not conclusive on the performance of the treatments over either base type. In fact, the data show negative benefit from their usage. Some doubt exists as to whether or not further surveys of the test sections would produce useful information. The need to make after-the-fact adjustments on the preconstruction data of both test sections has decreased the validity of statistical calculations and conclusions on the relative effectiveness of the crack-retarding treatments. Also, comparing the present reflective cracking to the cracking in the preconstruction surface may not be effective in determining treatment performance.

SECTION III
MAXWELL AFB, ALABAMA,
PRECONSTRUCTION SURVEY AND EVALUATION

A. INTRODUCTION

A test section was constructed at Maxwell AFB, Alabama, in July 1988 to determine the effectiveness of six different nonwoven filter fabric interlayers in reducing reflective cracking in AC overlays on a nontrafficked pavement. The test section is a recreational area that will serve as volleyball courts, and the section was built on an abandoned runway. The surface of the runway was 3 inches of AC over 7 inches of asphalt macadam over 6 inches of broken PCC. A preconstruction cracking survey was performed to determine the amount of cracking and to calculate a PCI.

B. PRECONSTRUCTION CRACKING SURVEY

Each volleyball court measures 50 by 80 feet; the courts are arranged about the old runway center line (Figure 45). A preconstruction cracking survey of each court was performed to determine the amount of cracking and to calculate a PCI. The asphalt surface exhibited extensive block cracking that was low to medium in severity (Figure 46) with some of the larger cracks filled with debris and vegetation. The cracking was measured in linear feet and is given in Table 14 along with the PCI of each court. The cracking in the AC surface was all considered block cracking in the calculation of the PCI. The difference in the PCI is borne from the severity rating of the cracking. The cracking in Court 1 was 100 percent light severity, the cracking in Court 2 was 60 percent light severity and 40 percent medium severity, the cracking in Court 3 was 20 percent light severity and 80 percent medium severity, and the cracking in Courts 4 through 7 was 100 percent medium severity.

C. TEST SECTION CONSTRUCTION

The courts were constructed as illustrated in Figure 45 with a fabric interlayer beneath the AC overlay in six courts and one court as a control section with no interlayer. The fabric name, weight per square yard, and manufacturer for each respective section are as follows:

1. Trevira®, 4 ounce, Hoechst Corporation
2. MIRAFI®, 4 ounce, Celanese Fibers Marketing Company
3. Poly Filter X, 4 ounce, Carthage Mills
4. AmoPave® (4599), 6 ounce, Amoco Fabrics Company
5. Petromat®, 6 ounce, Phillips Fibers Corporation
6. Petromat®, 4 ounce, Phillips Fibers Corporation

To obtain the best results in the test section performance, the pavement was prepared before construction. The debris and vegetation were removed and the cracks filled with sand asphalt. The cracks in Sections 1, 2, 3, and 7 were filled individually, as shown in Figure 47. The individually filled cracks were overfilled, the filler was compacted with a steel-wheeled roller, and the excess was removed by a front-end loader dragging its bucket on the pavement surface (Figure 48). The removal process was successful on these sections. On Test Sections 4, 5, and 6, the crack filler was dumped on the pavement surface, spread, and compacted with a steel-wheeled roller (Figure 49). The removal was again performed with the bucket of the front-end loader, but small areas which partially bonded to the old surface were not removed and may delaminate. The delamination is not expected to be a major problem since the surface will receive no traffic.

An AC-20 paving grade asphalt cement was used as a tack coat to bond the fabric to the old AC surface. The design spray application rates were 0.30 gallon per square yard for the 6-ounce fabrics and 0.25 gallon per square yard for the 4-ounce fabrics. These rates were achieved with the exception of Section 6 where 0.50 gallon per square yard was placed. This rate was deemed acceptable by the Phillips Fabric Company representative who was present during construction. A 2-inch AC overlay was placed on each section after the placement of the fabric. Due to the unevenness of the old

surface, small variances on the thicker side of 2 inches were required to maintain a smooth surface.

D. RECOMMENDATIONS

This initial preconstruction survey should be followed up with semi-annual to annual reflective cracking survey and evaluations to determine the performance of the various fabrics in the nontrafficked pavement section.

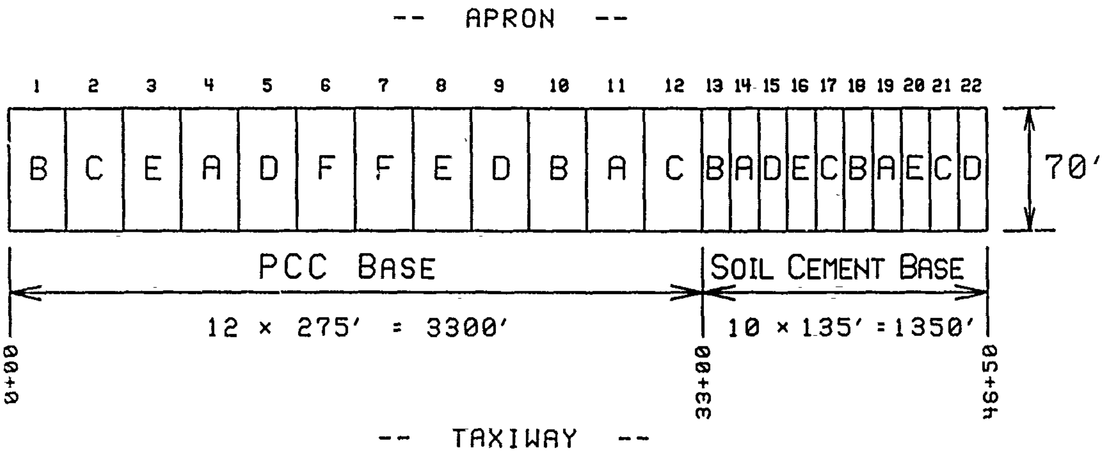
REFERENCES

1. Pavlovich, R. D. and McKeen, R. G., Monitoring of Test Sections Designed to Reduce Reflective Cracking, New Mexico Engineering Research Institute, Albuquerque, New Mexico, November 1987.

2. Headquarters, Department of the Air Force, Airfield Pavement Evaluation Program, Air Force Regulation AFR 93-5, Washington, D. C., 1981.

3. Ahlrich, R. C., Evaluation of Asphalt Rubber and Engineering Fabrics as Pavement Interlayers, Miscellaneous Paper GL-86-34, U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi, November 1986.

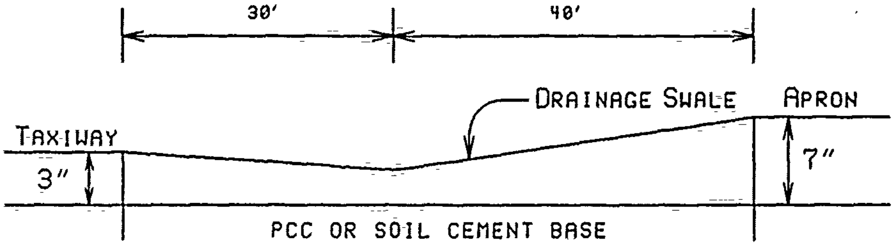
4. McGhee, K. H., Efforts to Reduce Reflective Cracking of Bituminous Concrete Overlays of Portland Cement Concrete Pavements, Virginia Highway and Transportation Research Council, Charlottesville, Virginia, 1975.



DESIGN TEST SECTION LAYOUT

TREATMENT DESIGNATIONS

A – CONTROL
B – ASPHALT-RUBBER
C – MODIFIED ASPHALT-RUBBER
D – RUBBER FILLED AC
E – FABRIC
F – SAWED AC



TYPICAL CROSS SECTION

Figure 1. Layout of Peterson AFB Test Section.

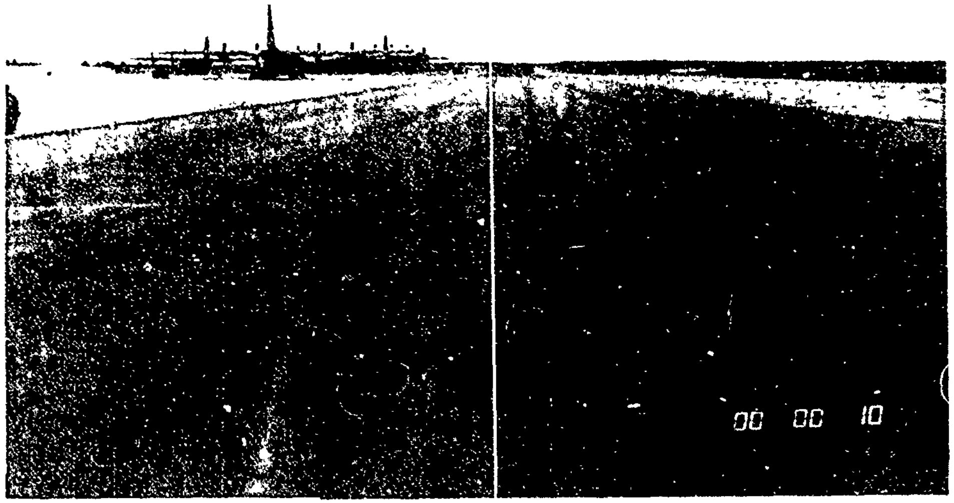


Figure 2. General View of AC Paving Joint Cracking.

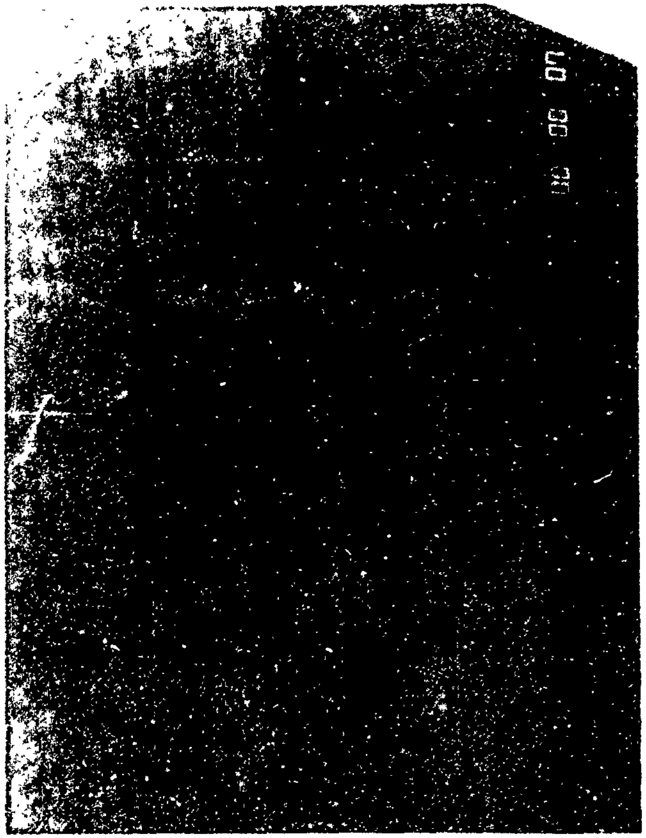


Figure 3. AC Paving Joint Crack between Saw Cuts in Section 7.

Figure 4. Medium-Severity Paving Joint Crack at Base of Drainage Swale, Section 1 (SAMI).

Figure 5. Closeup of Medium-Severity Paving Joint Crack, Section 1 (SAMI).

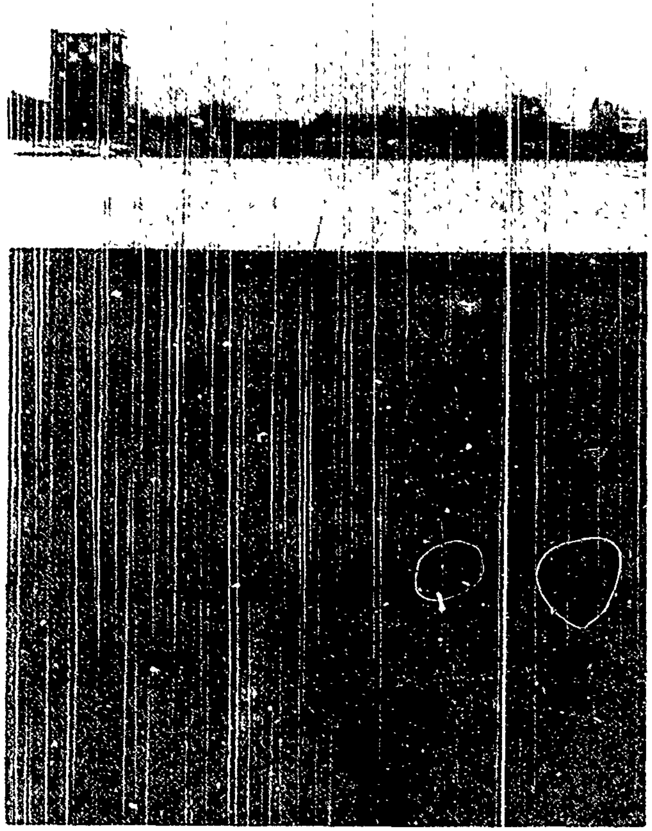


Figure 6. Full-Width Transverse Reflective Crack, Section 2 (Modified SAMI).

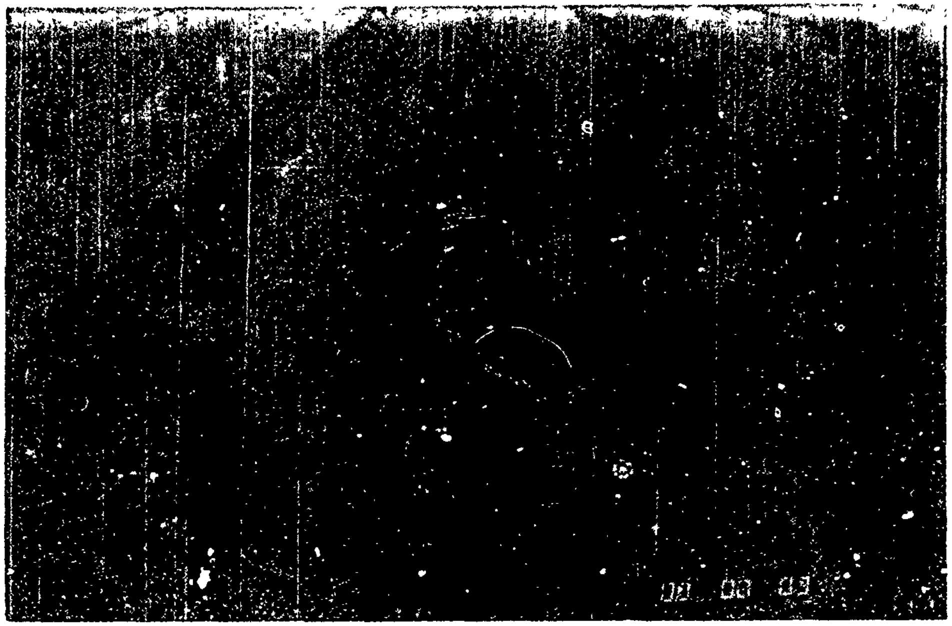


Figure 7. Intersection of Horizontal and Transverse Reflective Crack, Section 3 (Fabric).

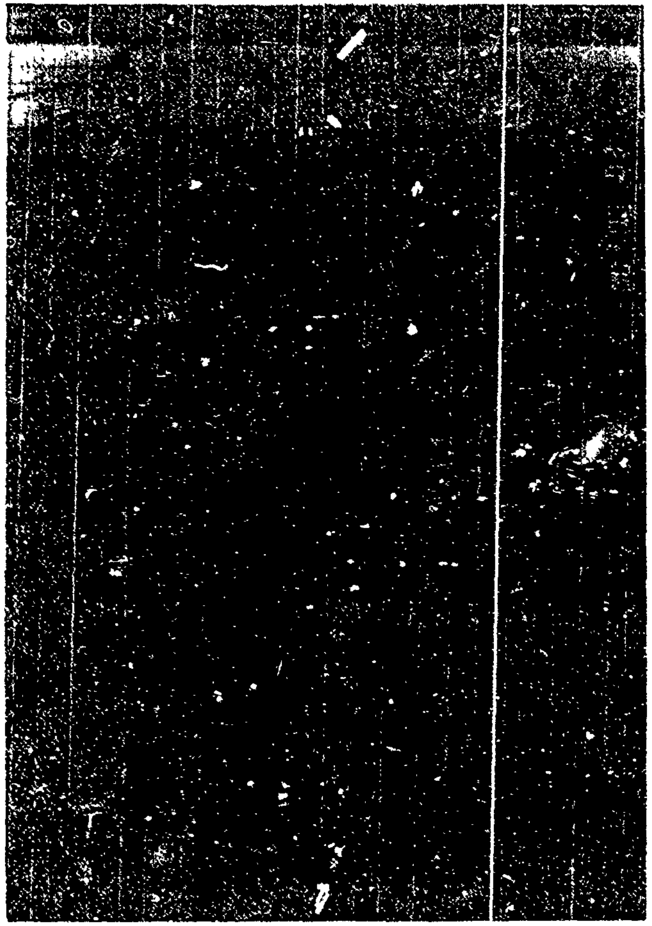


Figure 8. Typical Transverse Reflective Cracking, Section 3 (Fabric).

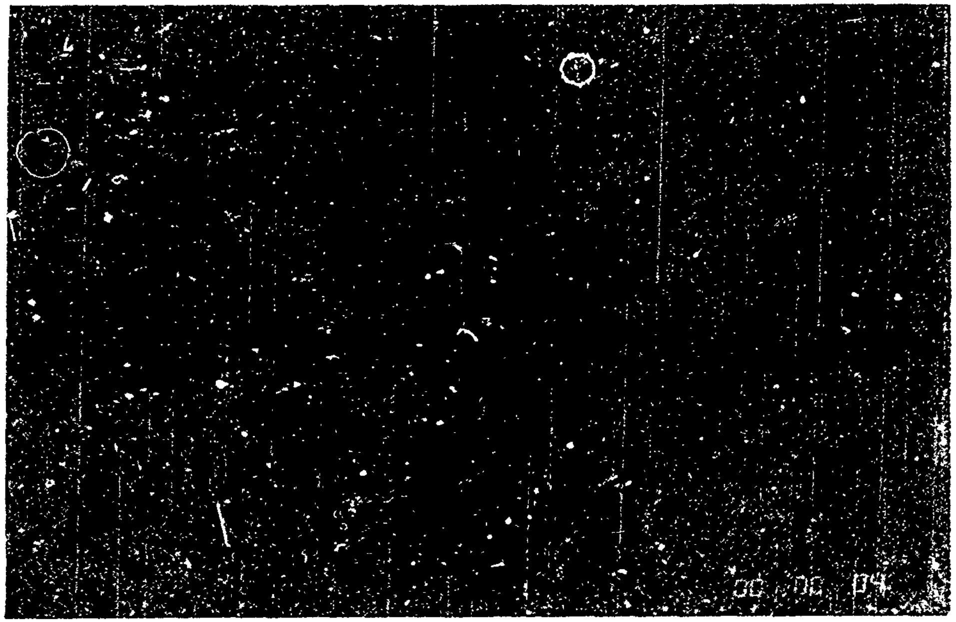


Figure 9. Reflective Cracking about Paving Joint Crack, Section 4 (Control).

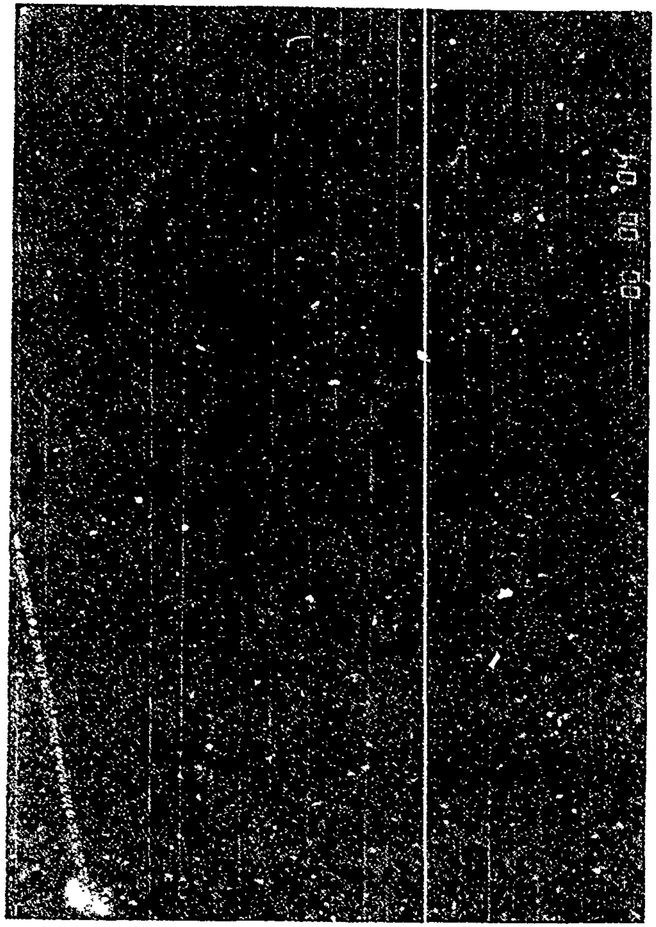


Figure 10. Cracking Adjacent to Paving Joint Crack, Section 4 (Control).

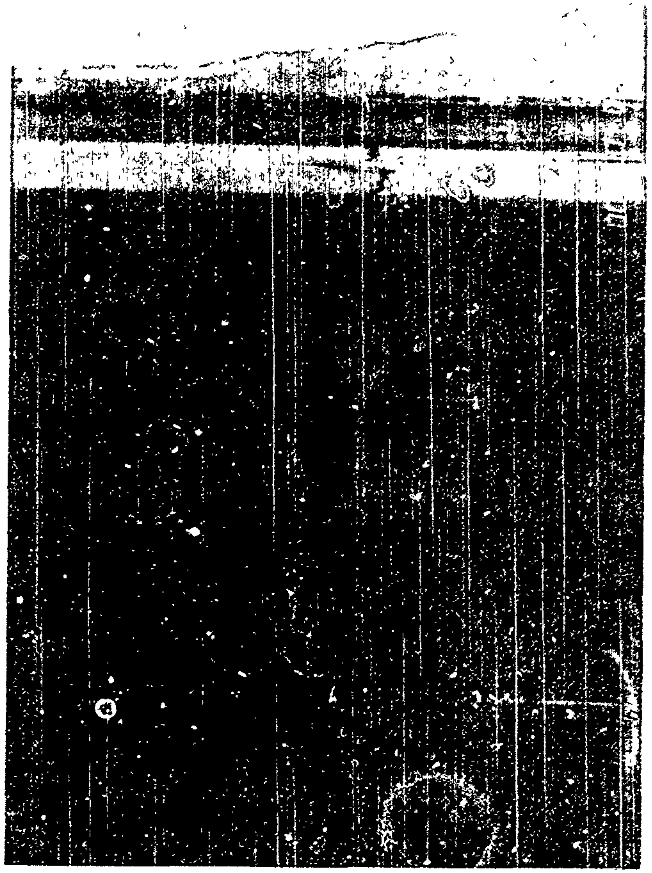


Figure 11. Transverse Reflective Crack, Section 5 (RFAC).

Figure 12. Hairline Reflective Crack, Section 5 (RFAC).

Figure 13. Longitudinal Reflective Cracking, Section 5 (RFAC).

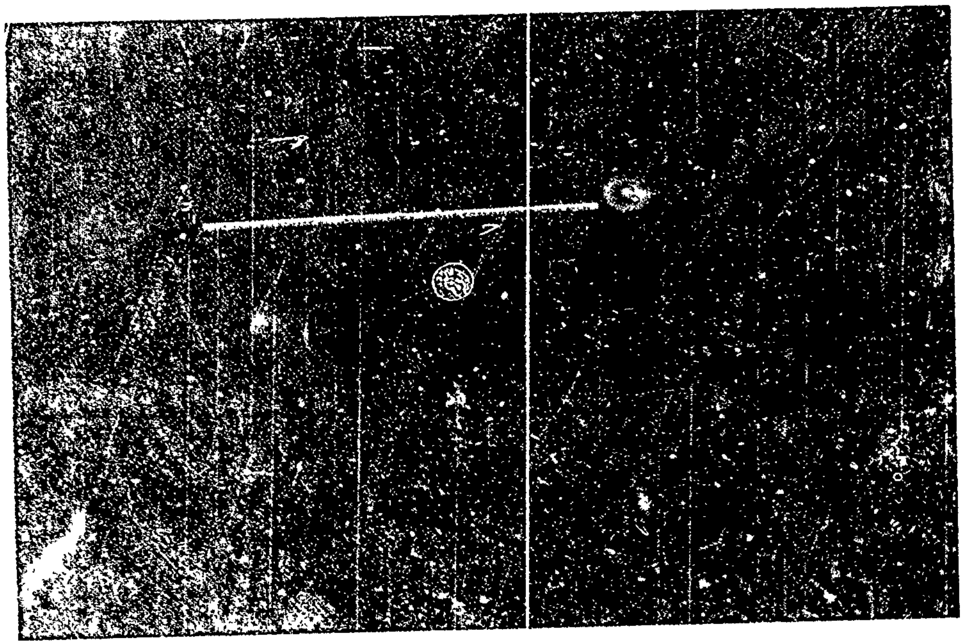


Figure 14. Cracking about Saw Cuts, Section 6 (Sawed).

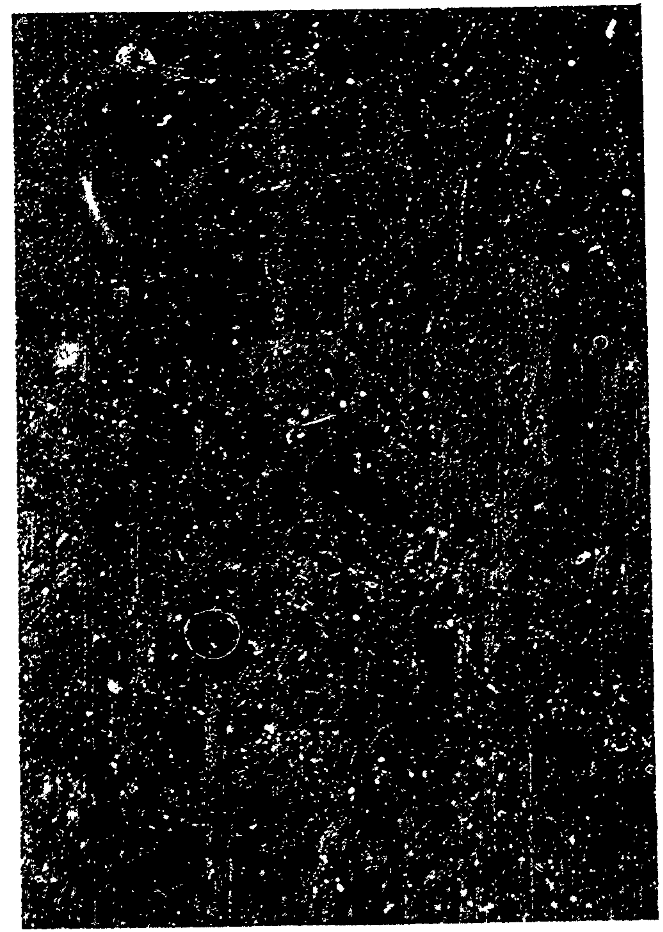


Figure 15. Typical Joint Sealant Condition, Sections 6 and 7 (Sawed).

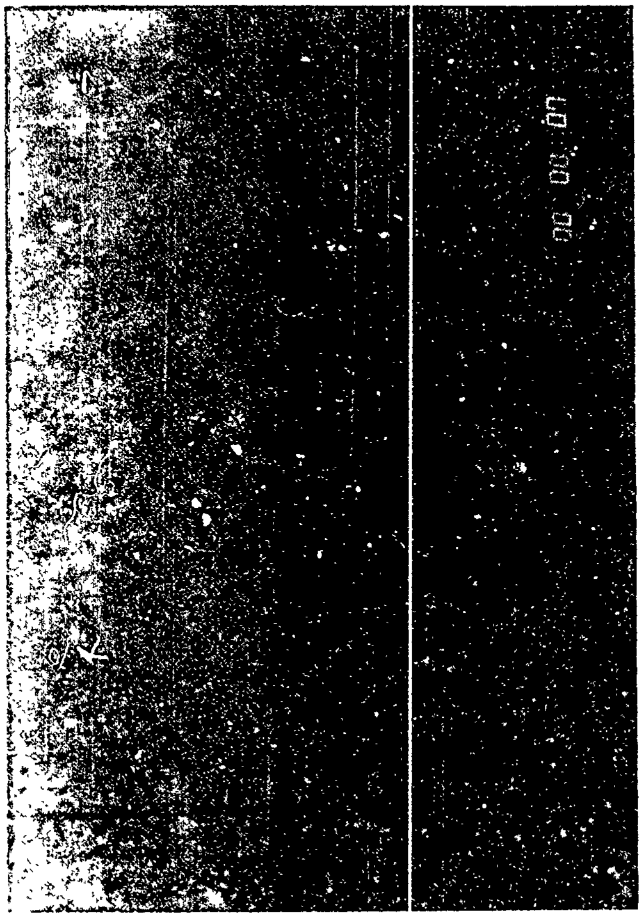


Figure 16. Paving Joint Cracking adjacent to Sawed Joint, Section 7 (Sawed).

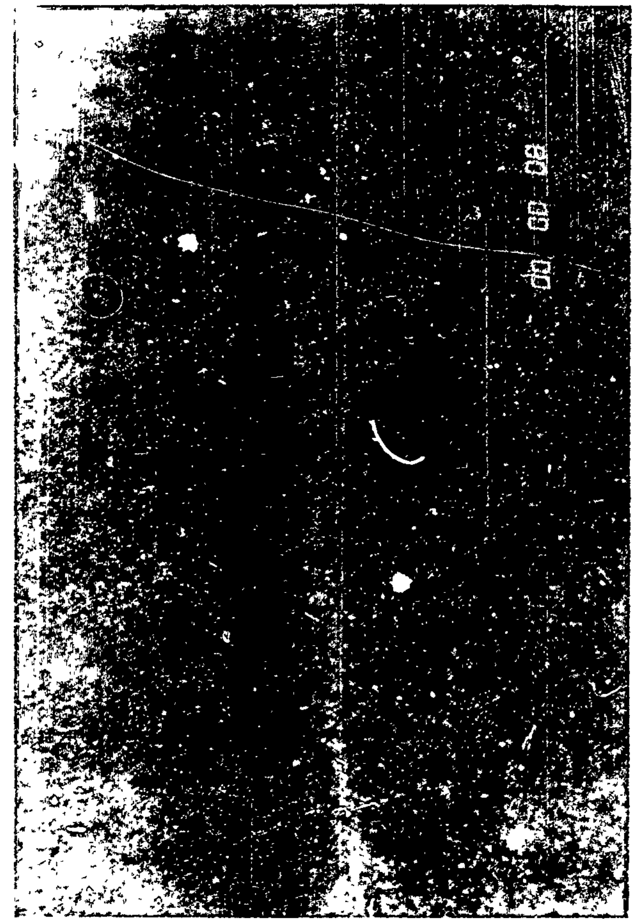


Figure 17. Reflective Crack Adjoining Saw Cut, Section 8 (Fabric).

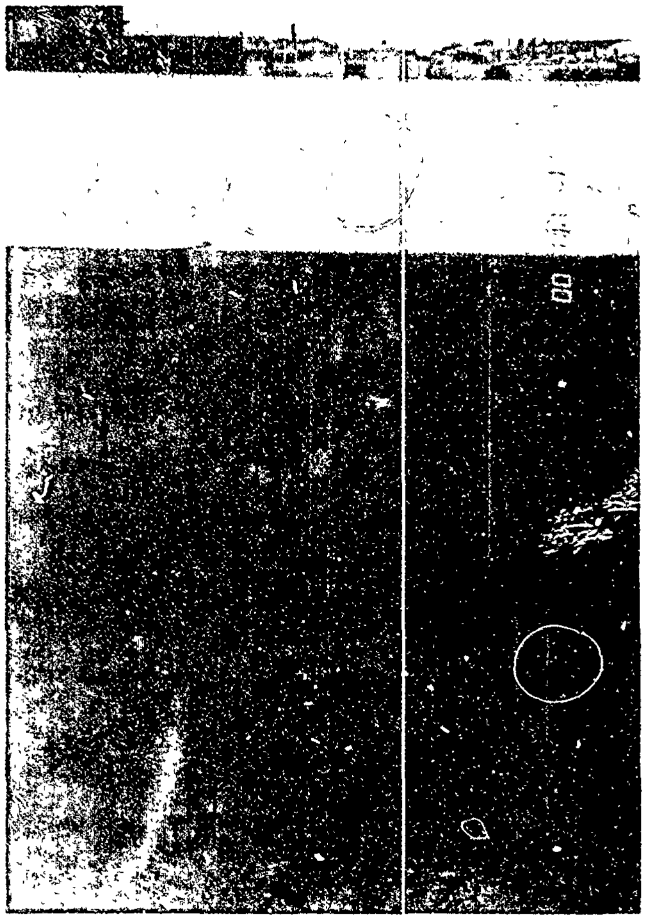


Figure 18. Transverse Reflective Crack, Section 8 (Fabric).

Figure 19. Longitudinal and Transverse Reflective Cracking, Section 9 (RFAC).

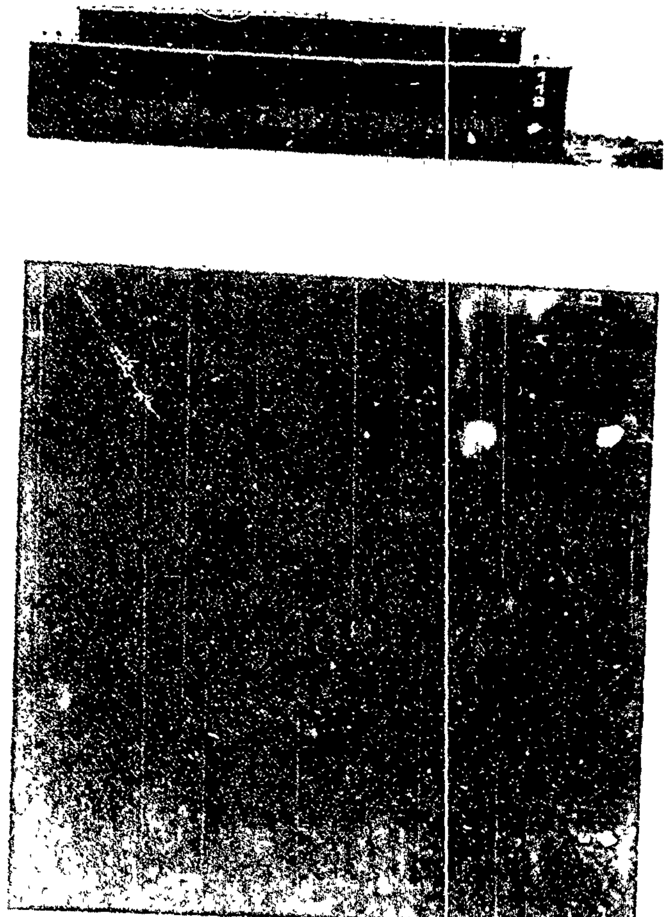


Figure 20. Transverse Reflective Crack Section 9 (RFAC).

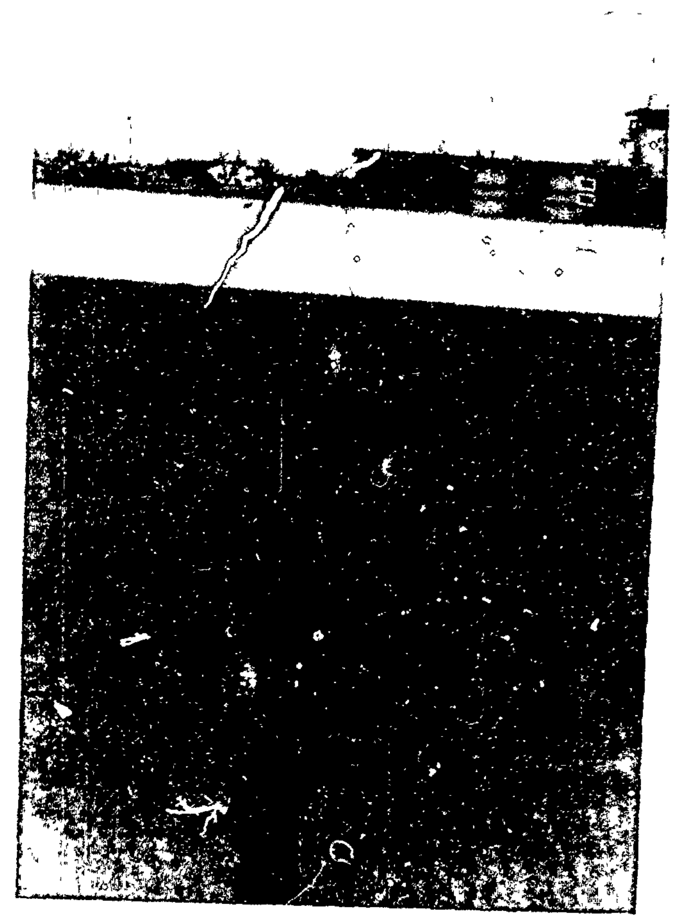


Figure 21. Transverse Reflective Crack, Section 10 (SAMI).

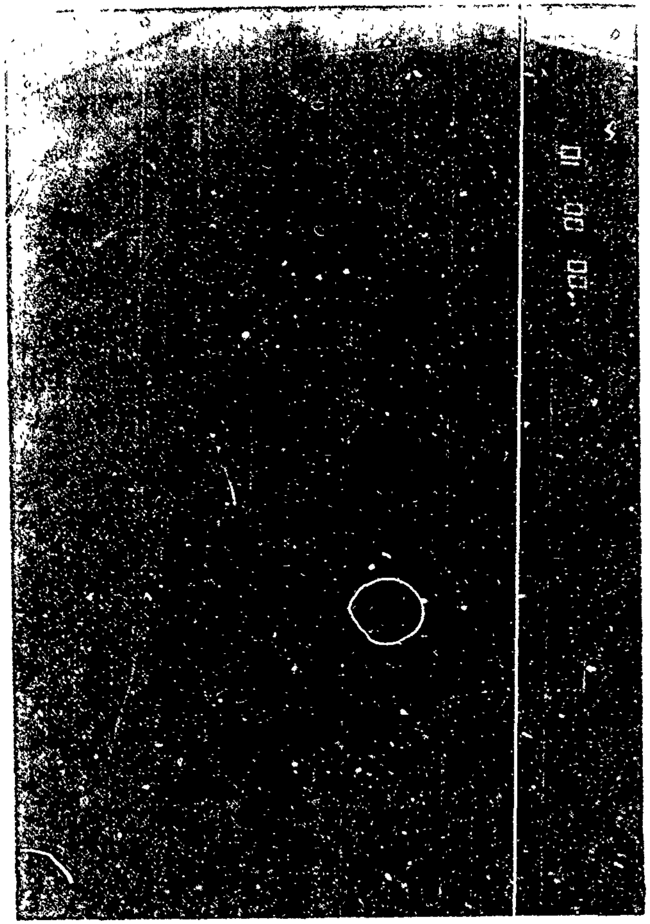


Figure 22. Reflective Crack adjacent to Paving Joint, Section 10 (SAMI).

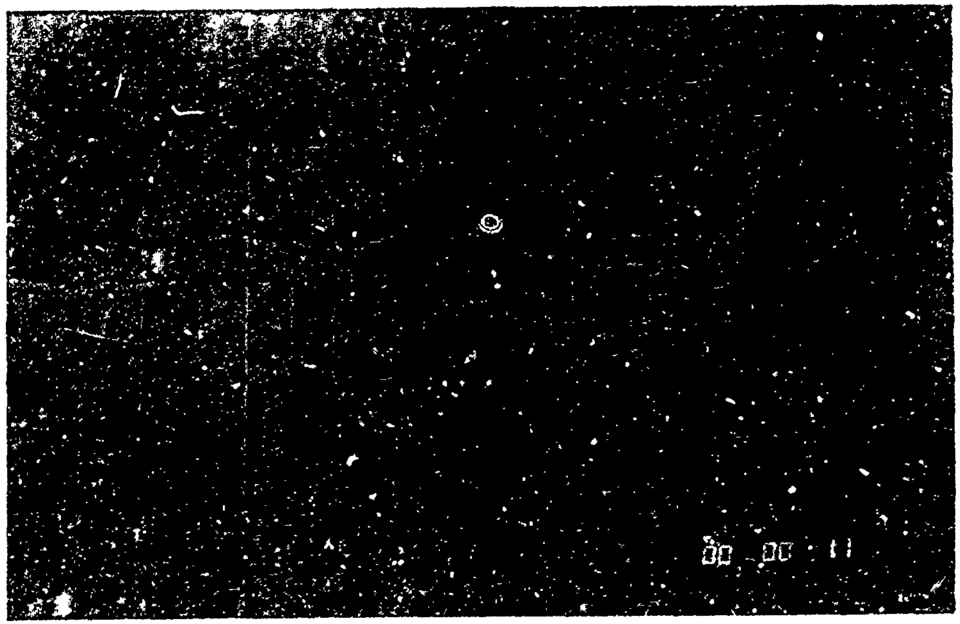


Figure 23. Transverse Reflective Crack Intersecting Paving Joint Crack, Section 11 (Control).

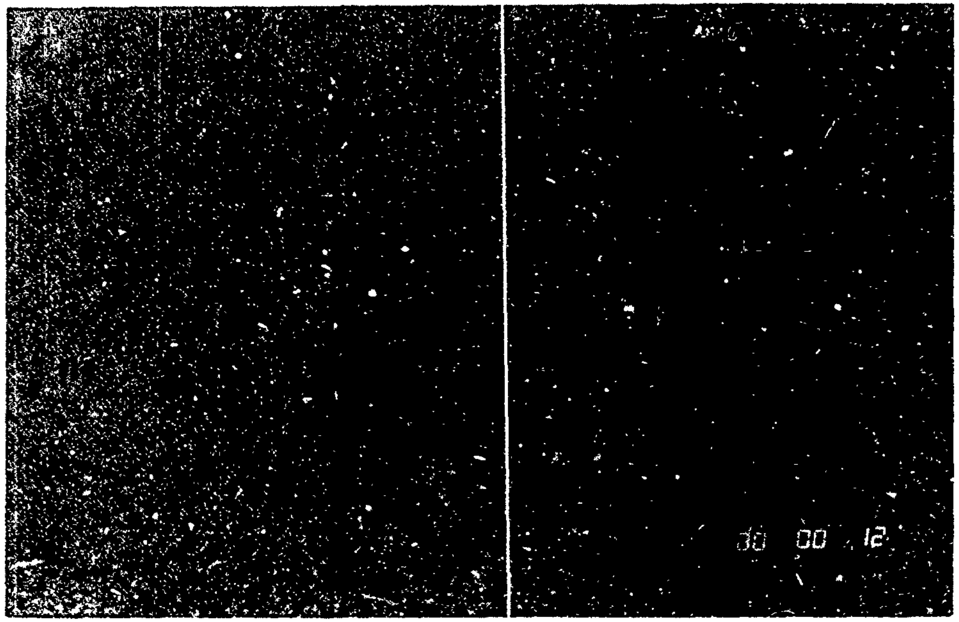


Figure 24. Transverse and Longitudinal Reflective Cracking, Section 12 (Modified SAMI).

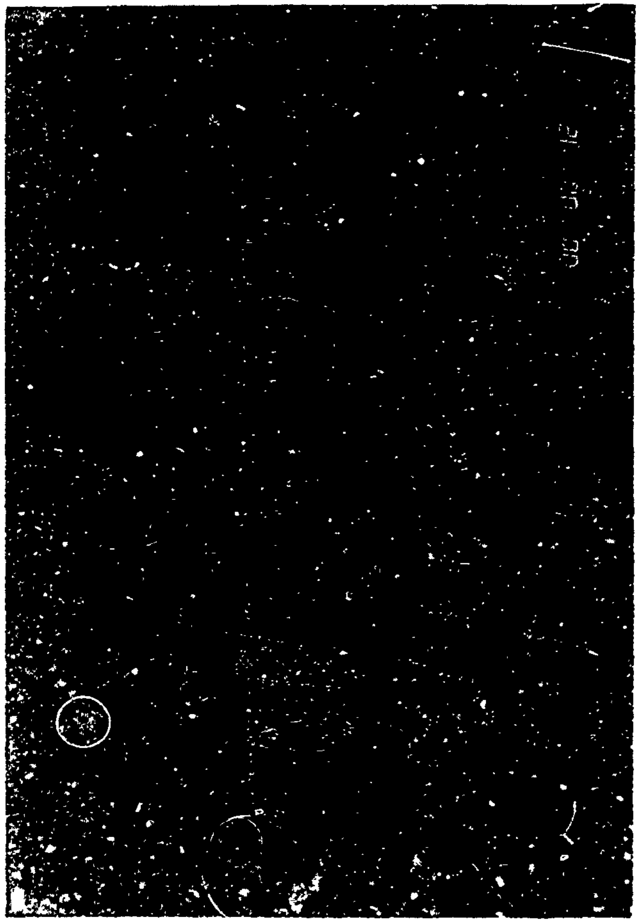
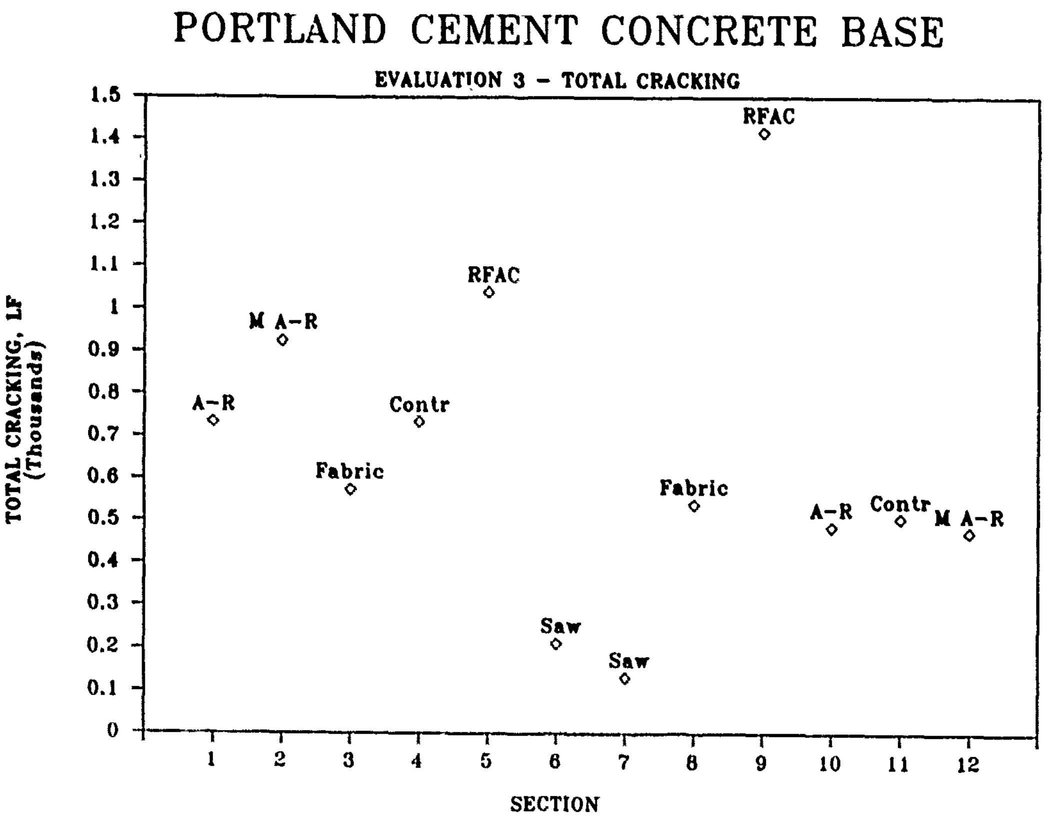


Figure 25. Medium-Severity Paving Joint Crack and Loose Aggregate, Section 12 (Modified SAMI).



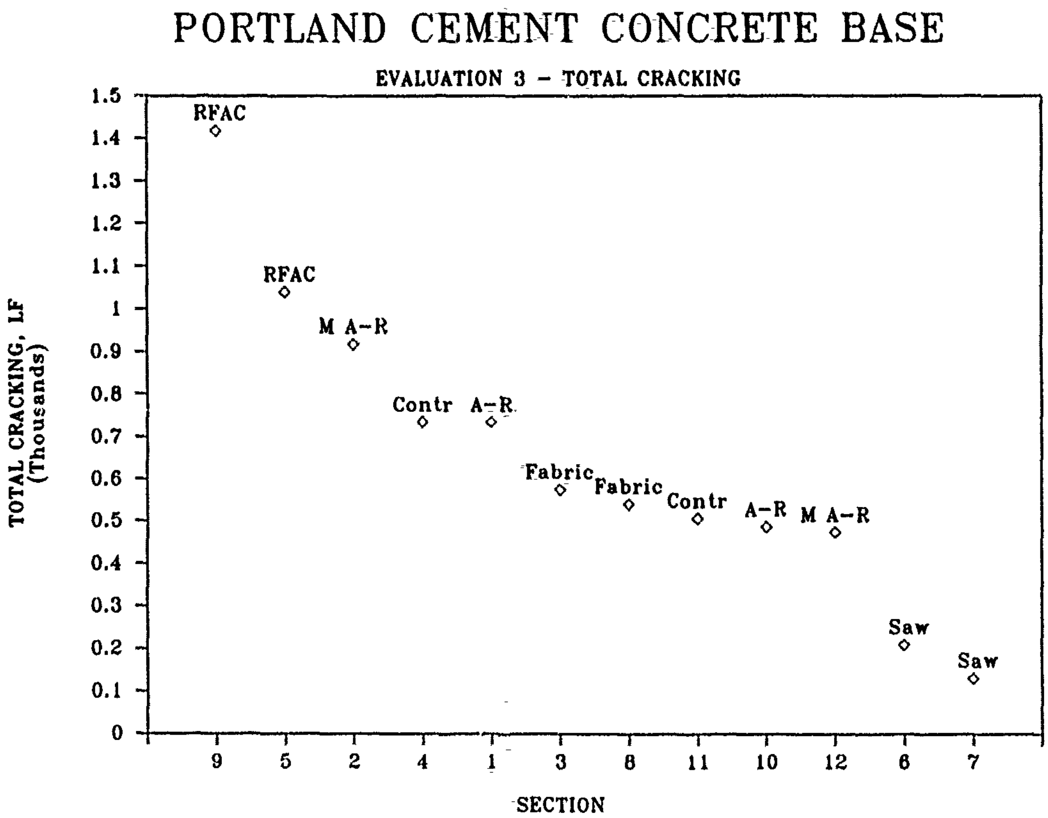
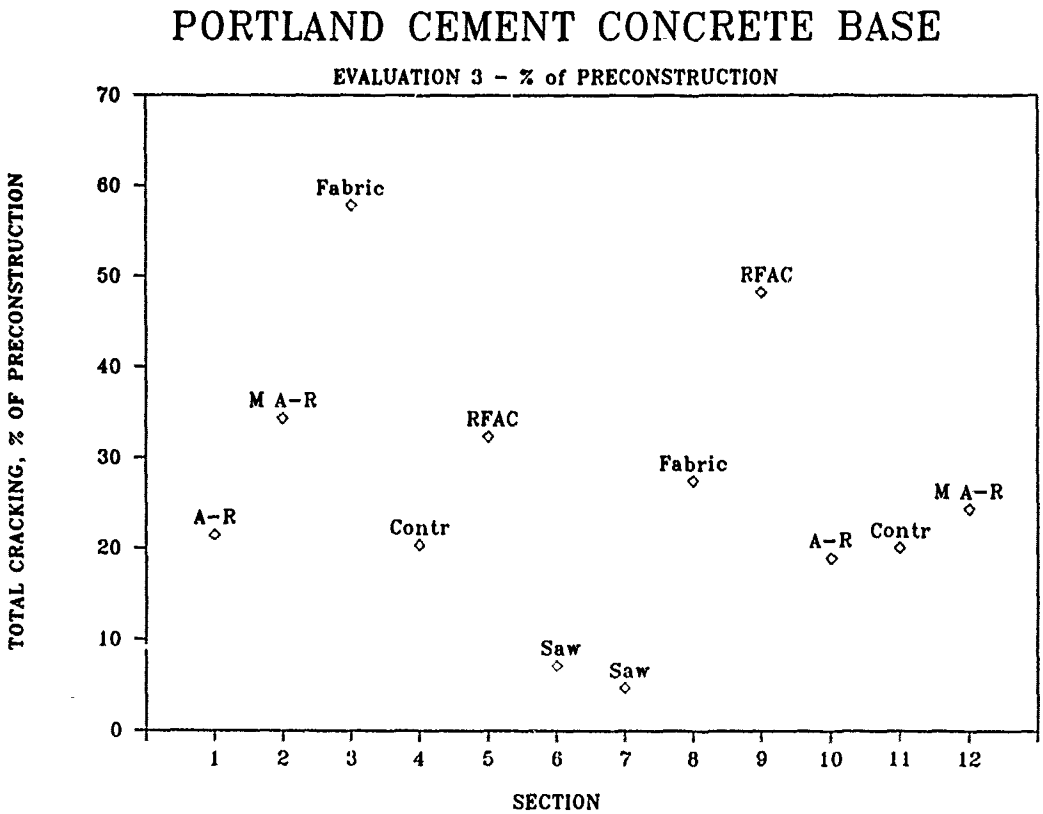


Figure 26. Total Cracking, PCC Base Test Section.



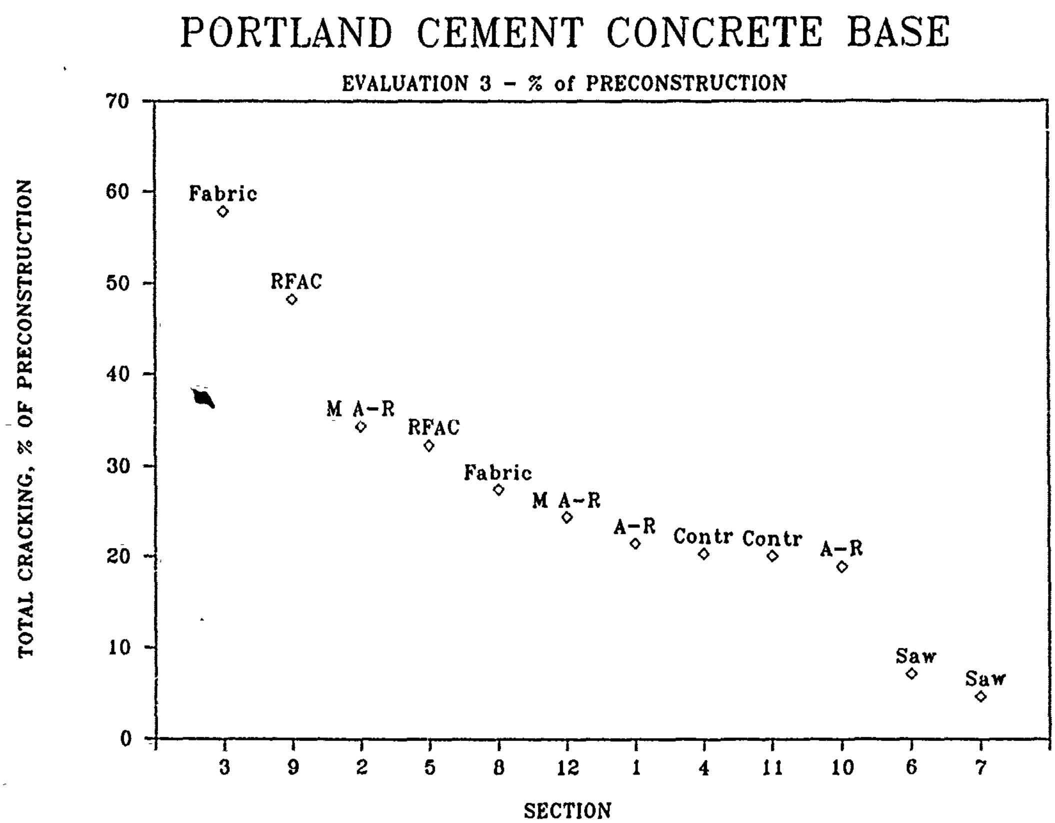


Figure 27. Cracking Relative to Preconstruction Cracking, PCC Base Test Section.

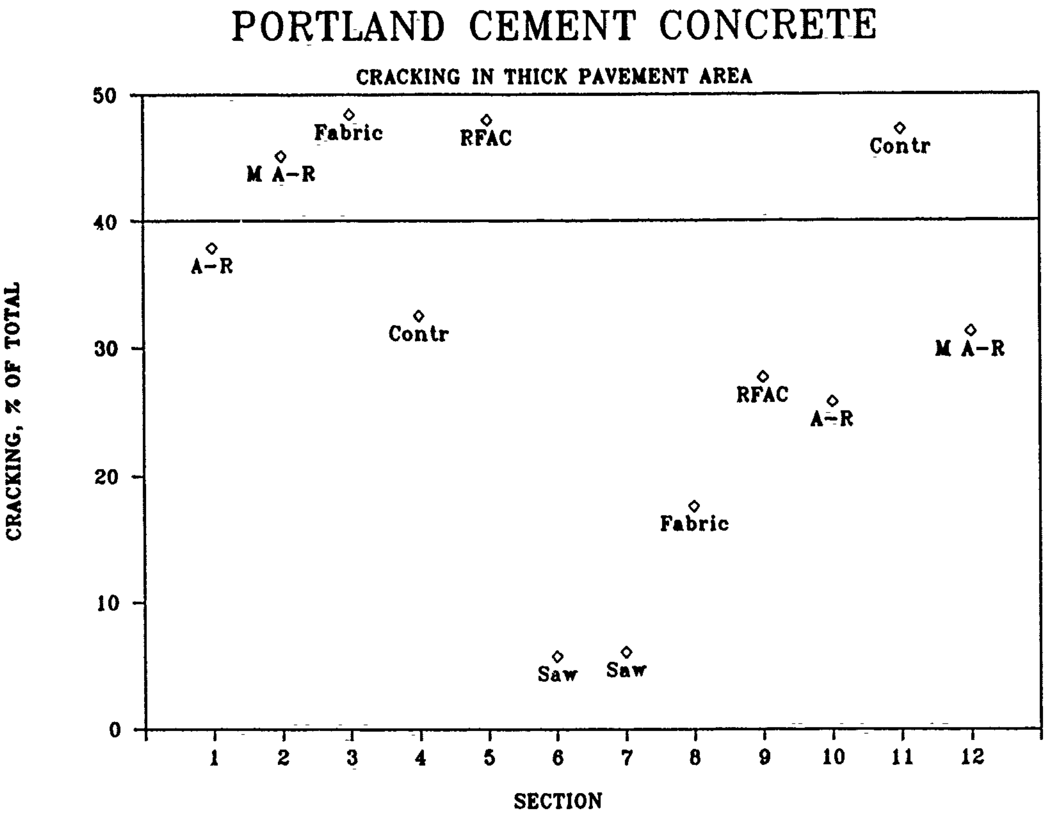


Figure 28. Cracking as a Function of Thickness, PCC Base Test Section.

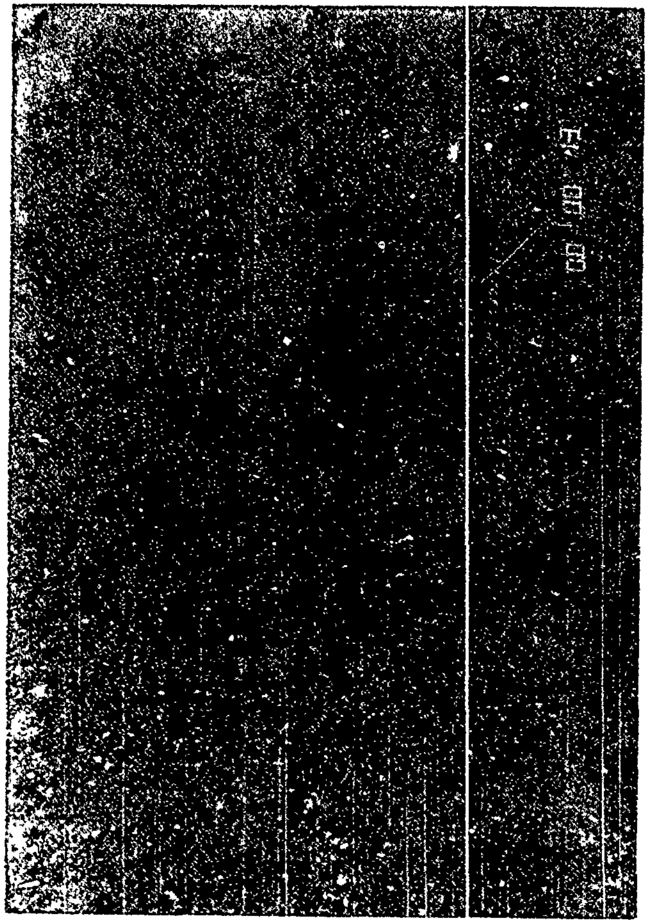


Figure 29. Typical Linear Reflective Cracking, Section 13 (SAMI).

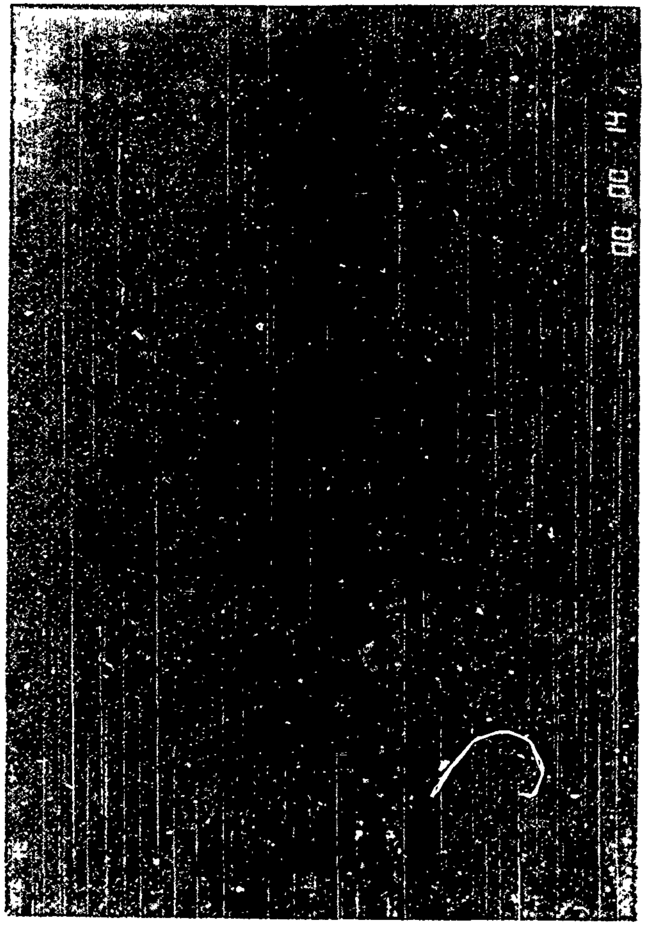


Figure 30. Typical Linear Reflective Cracking and High-Severity Paving Joint Crack, Section 14 (Control).

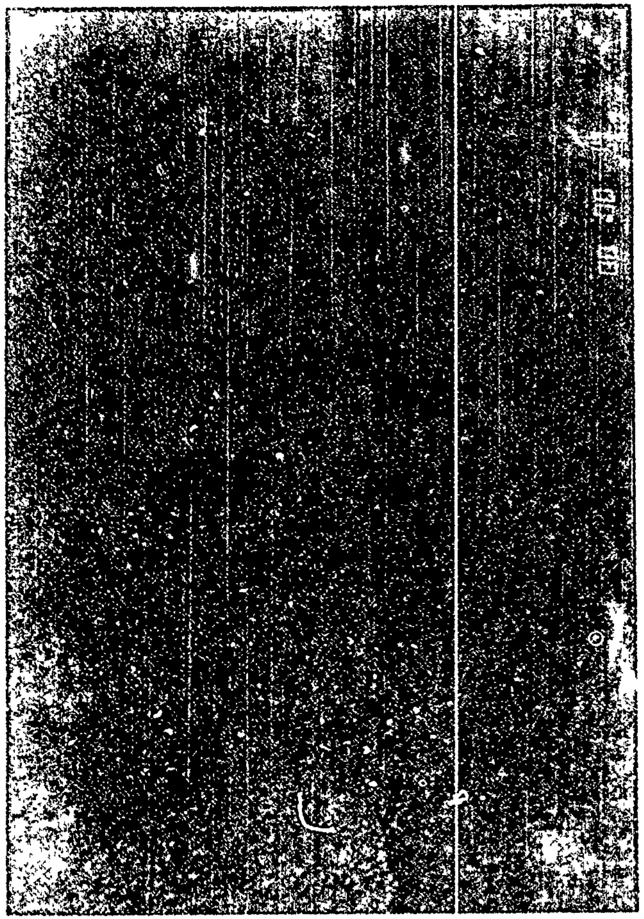


Figure 31. Typical Block Reflective Cracking, Section 14 (Control).

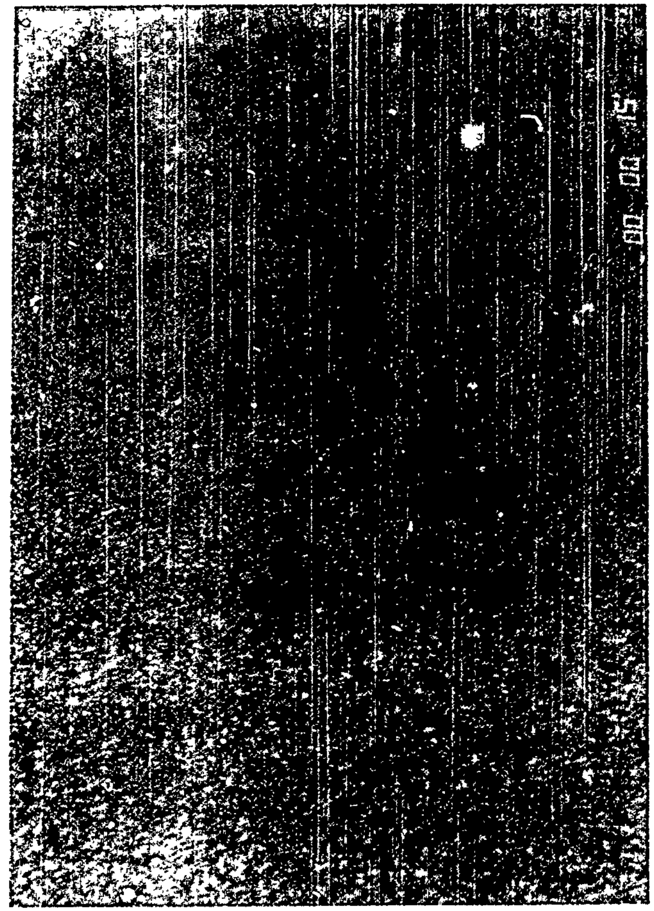


Figure 32. Medium-Severity Reflective Cracking, Section 15 (RFAC).

Figure 33. Low- and-Medium Severity Reflective Cracking, Section 16 (Fabric).

Figure 34. Medium-Severity Reflective Cracking, Section 16 (Fabric).

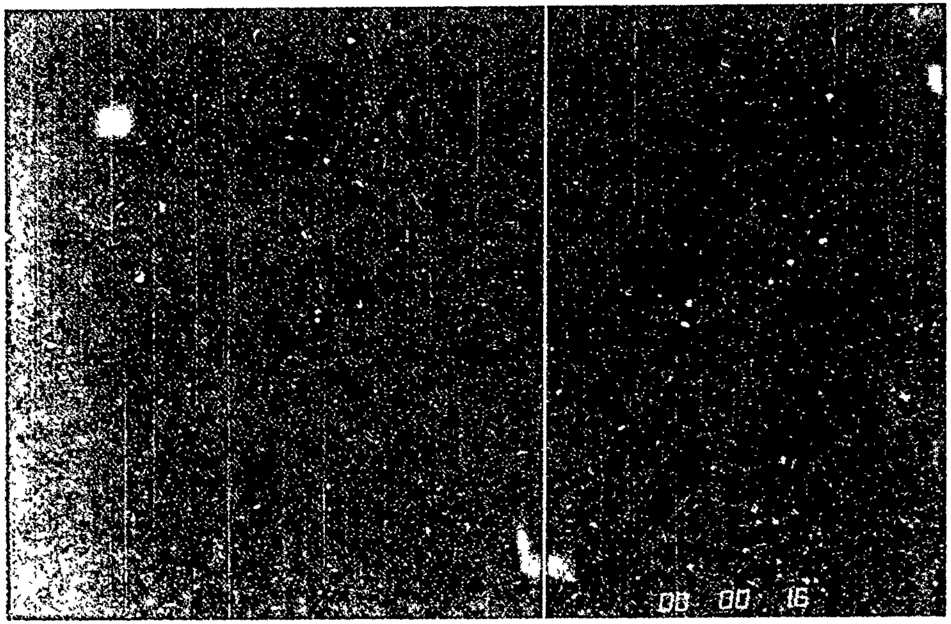


Figure 35. Block Reflective Cracking, Section 17 (Modified SAMI).

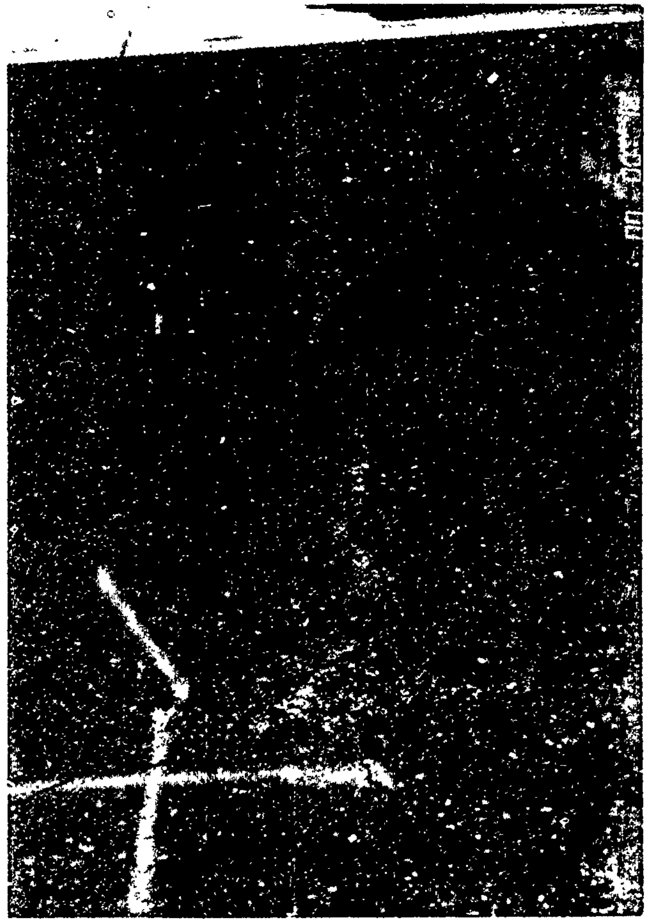


Figure 36. Linear Reflective Cracking, Section 18 (SAMI).

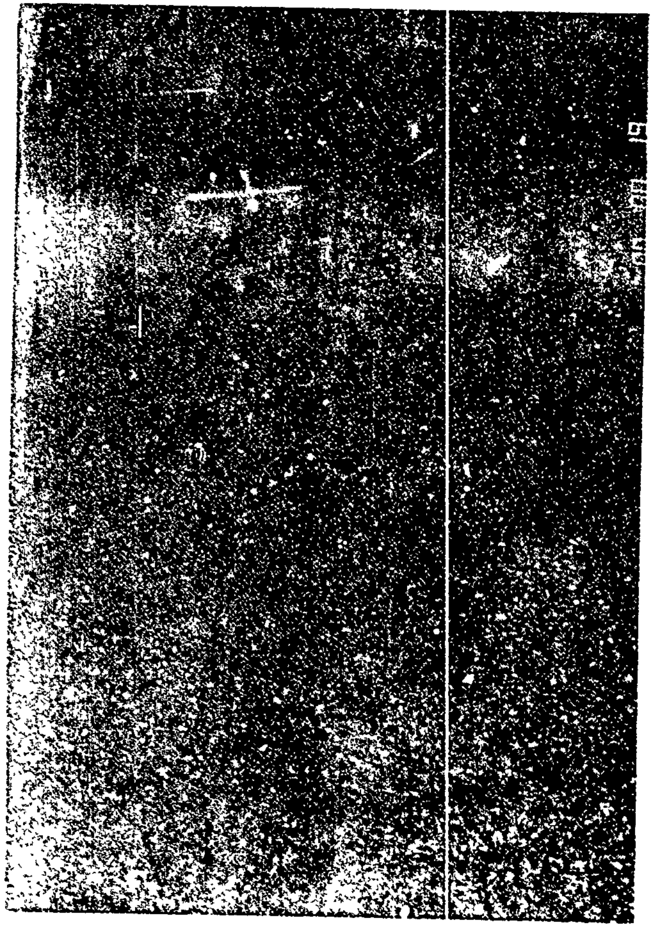
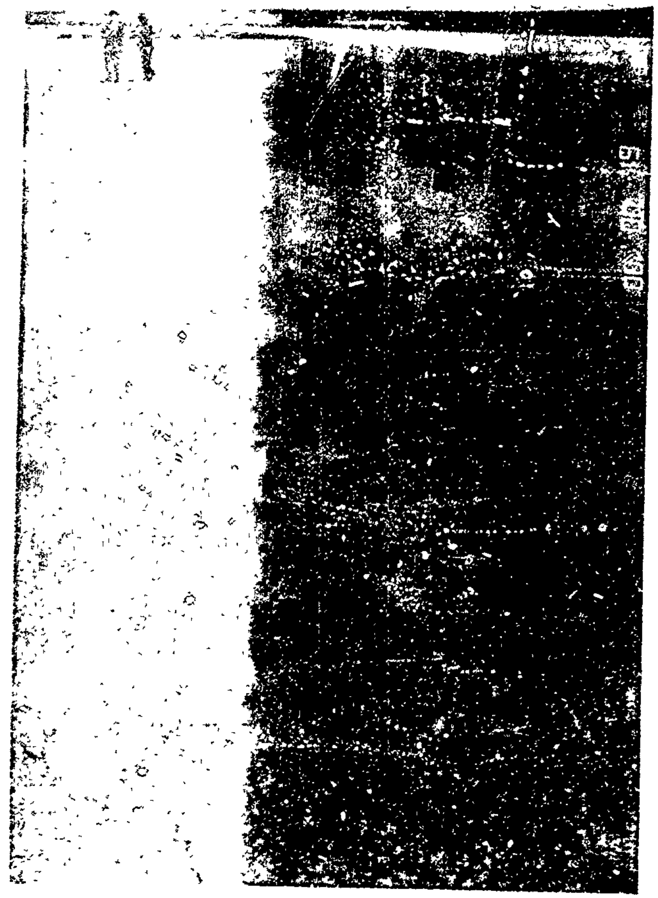


Figure 37. Closeup of Typical Block Reflective Cracking, Section 19 (Control).



Fi cal Block Reflective king, Section 19 (Control).

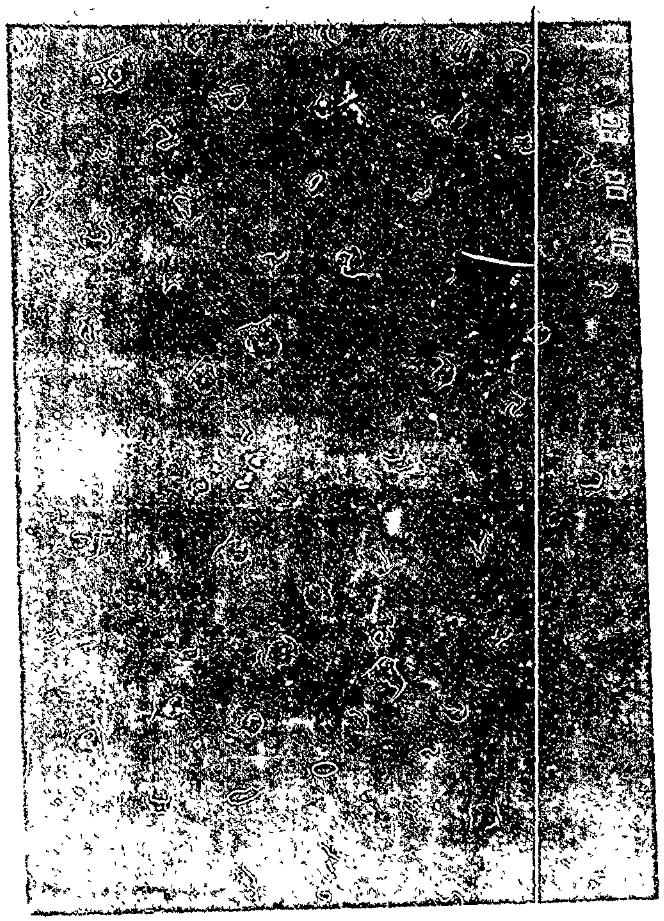
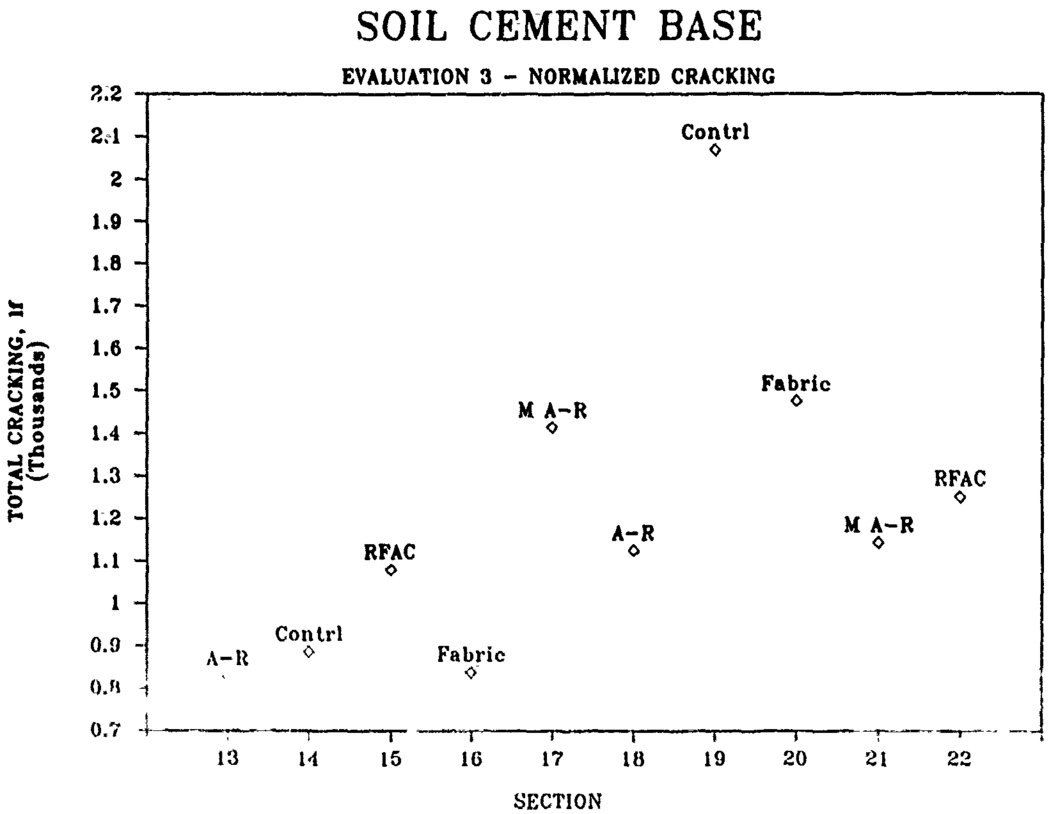


Figure 39. Typical Reflective Cracking, Section 20 (Fabric).

Figure 40. Typical Block Reflective Cracking, Section 20 (Fabric).

Figure 41. Typical Reflective Cracking, Section 21 (Modified SAMI).

Figure 42. Typical Linear Reflective Cracking, Section 22 (RFAC).



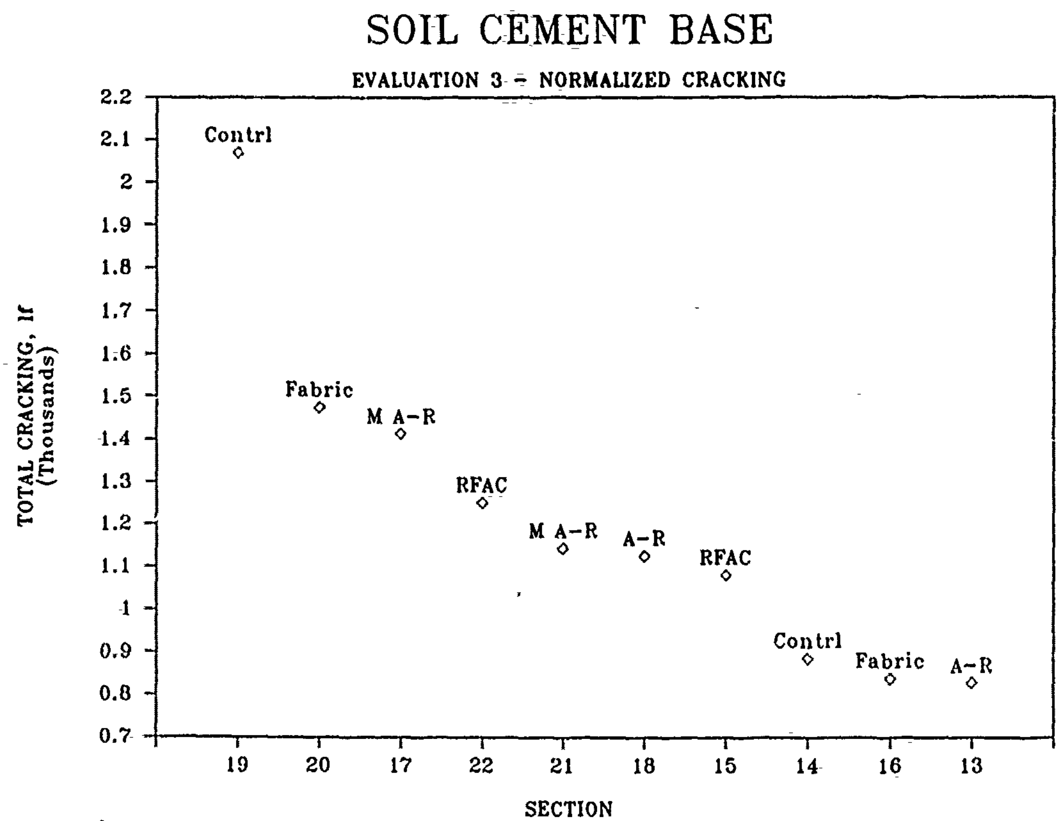
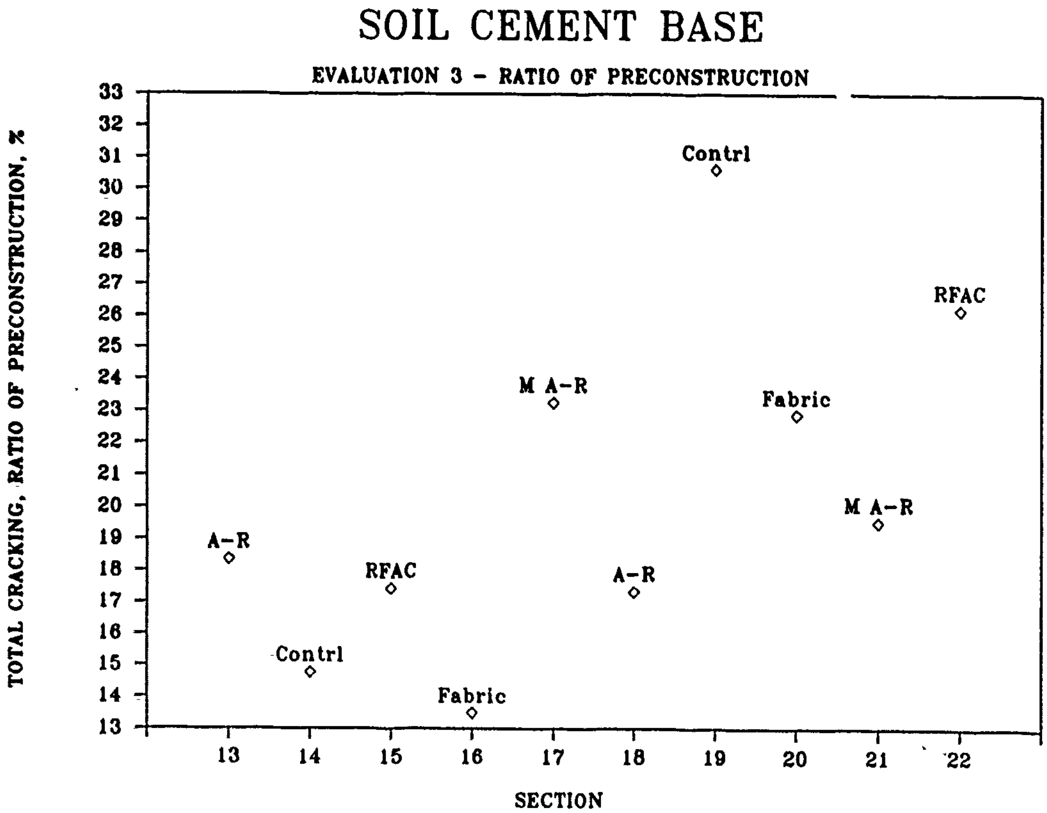


Figure 43. Total Cracking, Soil Cement Base Test Section.



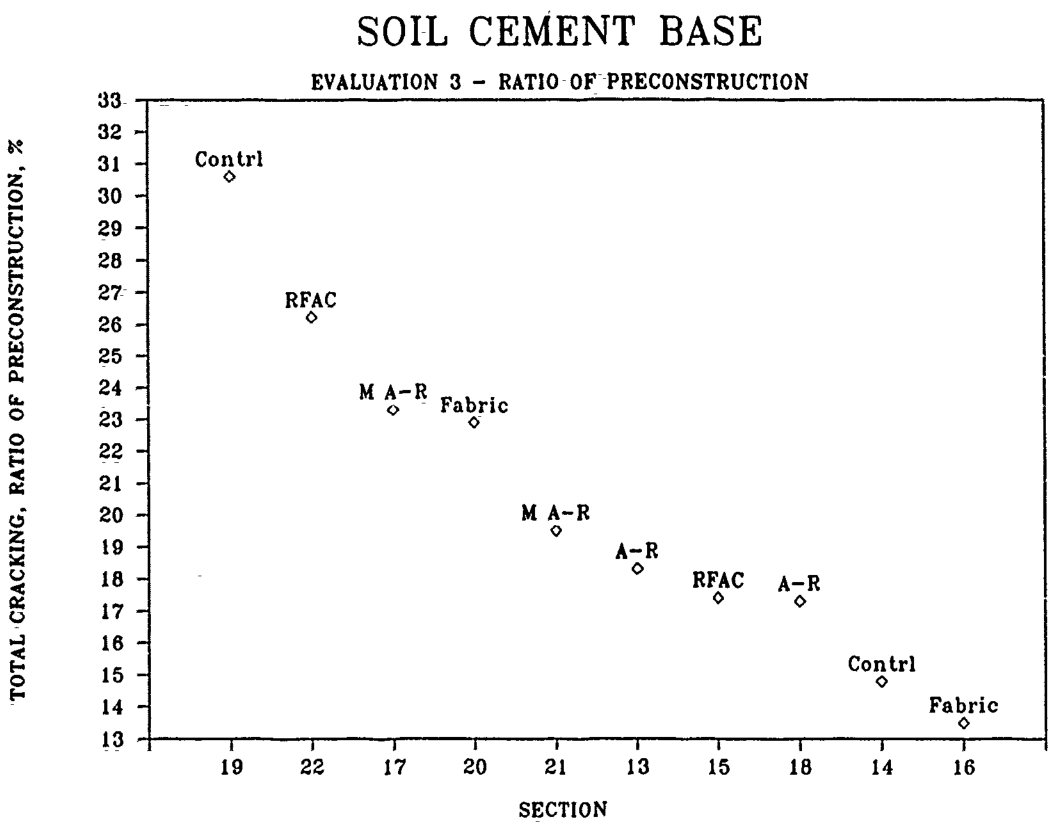


Figure 44. Cracking Relative to Preconstruction Cracking, Soil Cement Base Test Section.

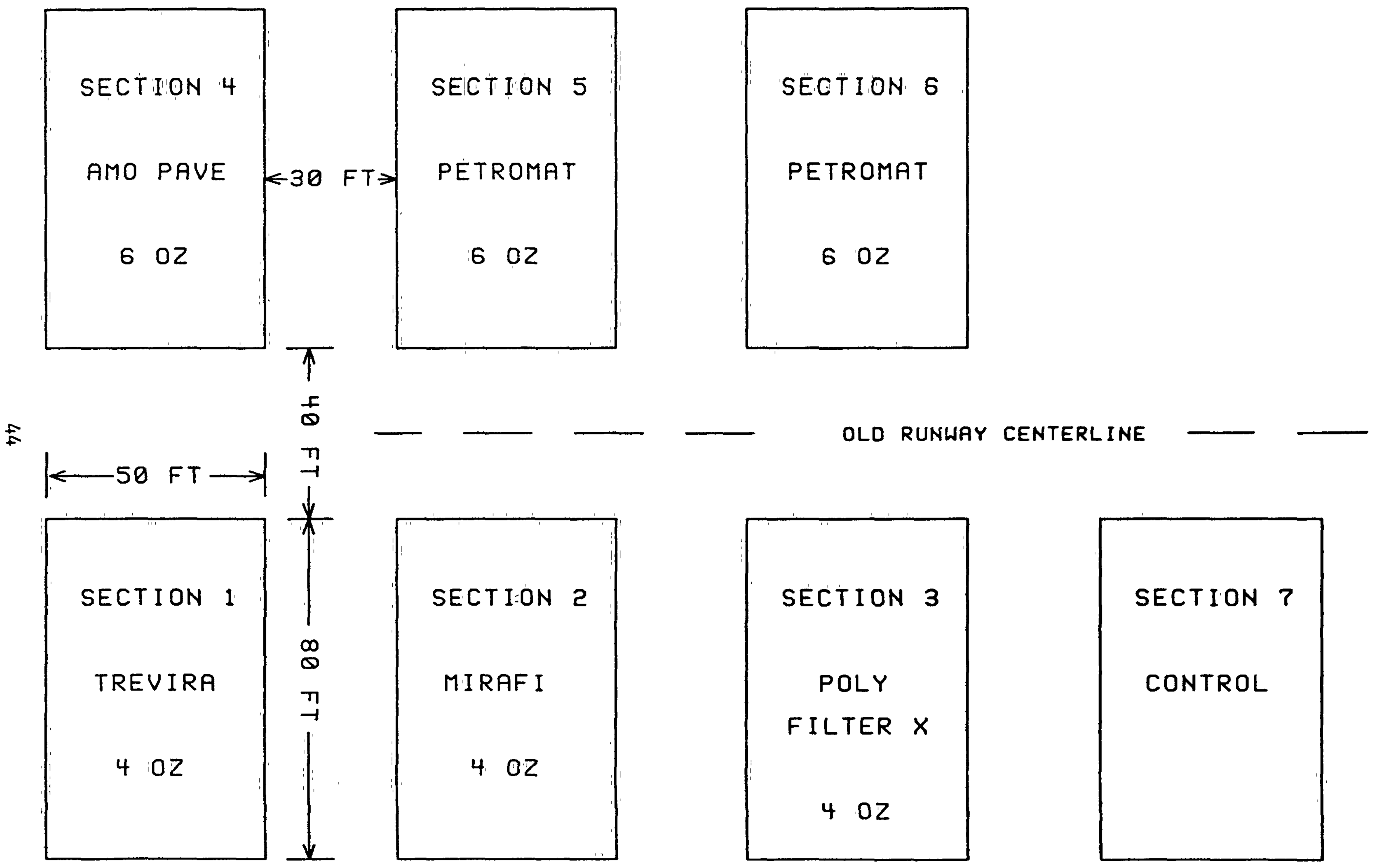


Figure 45. Layout of Maxwell AFB Test Section.

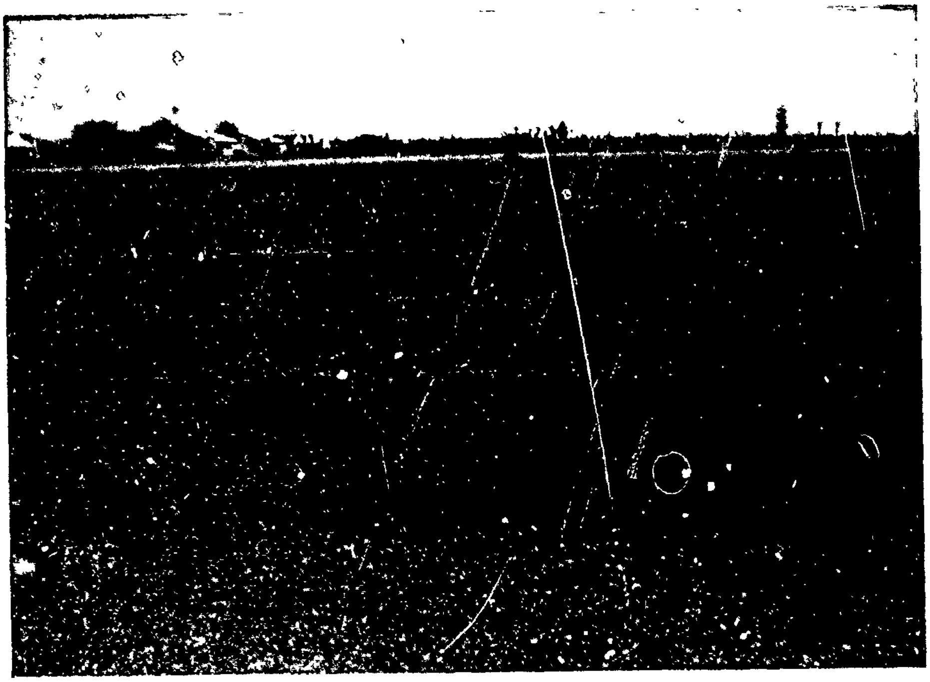


Figure 46. Typical Block Cracking, Maxwell AFB.

Figure 47. Individually Filled Cracks, Sections 1, 2, 3, and 7.

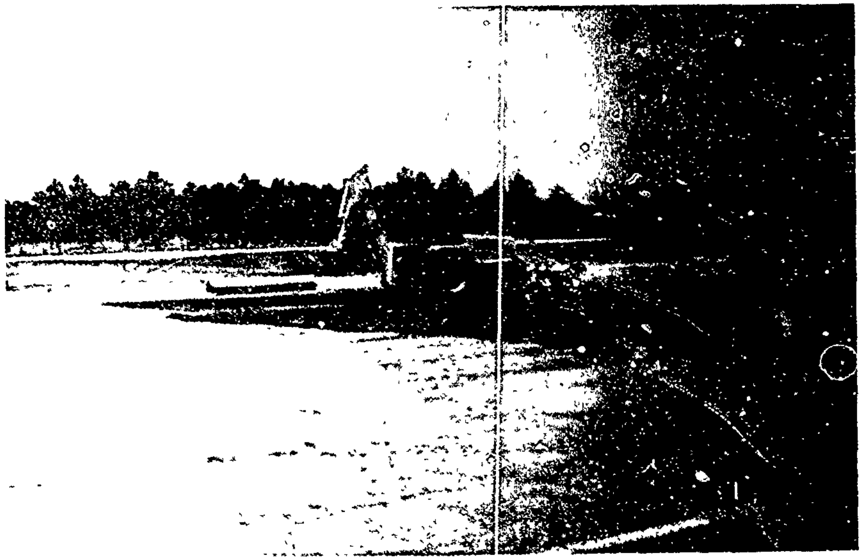


Figure 48. Removal of Excess Crack Filler, Maxwell AFB.

Figure 49. Surface after Crack Filling, Sections 4, 5, and 6.

TABLE 1. PAVEMENT PATCHING FROM PRECONSTRUCTION SURVEY FOR PCC BASE SECTIONS.

SECTION	PATCHING (SQ FT)	AREA OF SECTION WITHOUT PATCHING (SQ FT)	ADJUSTED[a] PRECONSTRUCTION CRACKING (LF)	CRACKING DIVIDED BY AREA (PERCENT)
1 (A-R)	--	19,250	3,417	17.75
2 (Mod. A-R)	2,000	17,250	2,696	15.63
3 (Fabric)	11,650	7,600	992	13.05
4 (Control)	--	19,250	3,611	18.76
5 (RFAC)	--	19,250	3,212	16.69
6 (Saw)	2,350	16,900	2,933	17.36
7 (Saw)	--	19,250	2,768	14.38
8 (Fabric)	5,755	13,495	1,964	14.55
9 (RFAC)	--	19,250	2,935	15.25
10 (A-R)	--	19,250	2,561	13.30
11 (Control)	--	19,250	2,519	13.09
12 (Mod. A-R)	4,935	14,315	1,939	13.55
Mean				15.27
Standard deviation				1.97
Coefficient of variation, percent				12.90

[a]255 lf subtracted from Section 12.

TABLE 2. ADJUSTED PRECONSTRUCTION CRACKING SURVEY TOTALS FOR SOIL CEMENT BASE SECTIONS.

SECTION	SECTION LENGTH, FT	ADJUSTED PRECONSTRUCTION CRACKING, SQ FT	NORMALIZED PRECONSTRUCTION CRACKING, SQ FT
13 (A-R)	150	5,015	4,513
14 (Control)	135	6,000	6,000
15 (RFAC)	135	6,205	6,205
16 (Fabric)	110	5,065	6,216
17 (Mod. A-R)	135	6,080	6,080
18 (A-R)	135	6,495	6,495
19 (Control)	135	6,755	6,755
20 (Fabric)	135	6,445	6,445
21 (Mod. A-R)	161	6,985	5,856
22 (RFAC)	126	4,455	4,773
Mean			5,933
Standard deviation			730
Coefficient of variation, percent			12.3

TABLE 3. SUMMARY OF CRACKING SURVEY 3 FOR PCC BASE SECTIONS.

STATION FROM	STATION TO	REFLECTIVE CRACKING (LF)	PAVING JOINT CRACKING (LF)	REFLECTIVE CRACKING IN PATCHED AREAS (LF)	TOTAL CRACKING (LF)
		Section 1 (Asphalt-Rubber)			
0+00	0+25	63	25	0	88
0+25	0+50	60	25	0	85
0+50	0+75	80	25	0	105
0+75	1+00	56	50	0	106
1+00	1+25	20	34	0	54
1+25	1+50	111	41	0	152
1+50	1+75	93	37	0	130
1+75	2+00	52	50	0	102
2+00	2+25	34	36	0	70
2+25	2+50	53	25	0	78
2+50	2+75	112	25	0	137
Totals		734	373	0	1,107
		Section 2 (Modified Asphalt-Rubber)			
2+75	3+00	59	25	0	84
3+00	3+25	58	25	0	83
3+25	3+50	90	25	0	115
3+50	3+75	146	25	0	171
3+75	4+00	61	25	0	86
4+00	4+25	103	35	0	138
4+25	4+50	108	42	0	150
4+50	4+75	76	51	0	127
4+75	5+00	124	46	0	170
5+00	5+25	106	50	60	156
5+25	5+50	89	45	33	134
Totals		1,020	394	93	1,414
		Section 3 (Fabric)			
5+50	5+75	46	112	20	158
5+75	6+00	75	100	15	175
6+00	6+25	22	122	5	144
6+25	6+50	60	125	21	185
6+50	6+75	71	102	9	173
6+75	7+00	46	114	9	160
7+00	7+25	63	125	0	188
7+25	7+50	132	125	35	257
7+50	7+75	44	125	0	169

TABLE 3. SUMMARY OF CRACKING SURVEY 3 FOR PCC BASE SECTIONS (CONTINUED).

STATION FROM	STATION TO	REFLECTIVE CRACKING (LF)	PAVING JOINT CRACKING (LF)	REFLECTIVE CRACKING IN PATCHED AREAS (LF)	TOTAL CRACKING (LF)
		Section 3 (Fabric) (Continued)			
7+75	8+00	131	125	29	256
8+00	8+25	70	119	43	189
Totals		760	1,294	186	2,054
		Section 4 (Control)			
8+25	8+50	73	100	0	173
8+50	8+75	78	125	0	203
8+75	9+00	41	116	0	157
9+00	9+25	79	112	0	191
9+25	9+50	89	106	0	195
9+50	9+75	49	84	0	133
9+75	10+00	55	108	0	163
10+00	10+25	77	107	0	184
10+25	10+50	52	102	0	154
10+50	10+75	30	122	0	152
10+75	11+00	112	91	0	203
Totals		735	1,173	0	1,908
		Section 5 (Rubber Filled AC)			
11+00	11+25	121	68	0	189
11+25	11+50	124	75	0	199
11+50	11+75	159	75	0	234
11+75	12+00	86	57	0	143
12+00	12+25	116	45	0	161
12+25	12+50	111	59	0	170
12+50	12+75	125	50	0	175
12+75	13+00	61	50	0	111
13+00	13+25	56	43	0	99
13+25	13+50	40	35	0	75
13+50	13+75	41	41	0	82
Totals		1,040	598	0	1,638
		Section 6 (Sawed)			
13+75	14+00	18	12	6	30
14+00	14+25	16	9	10	25
14+25	14+50	4	0	0	4
14+50	14+75	7	0	0	7

TABLE 3. SUMMARY OF CRACKING SURVEY 3 FOR PCC BASE SECTIONS (CONTINUED).

STATION FROM	STATION TO	REFLECTIVE CRACKING (LF)	PAVING JOINT CRACKING (LF)	REFLECTIVE CRACKING IN PATCHED AREAS (LF)	TOTAL CRACKING (LF)
		Section 6 (Sawed) (Continued)			
14+75	15+00	23	0	0	23
15+00	15+25	10	8	0	18
15+25	15+50	20	3	0	23
15+50	15+75	48	0	0	48
15+75	16+00	32	0	0	32
16+00	16+25	35	0	0	35
16+25	16+50	13	0	0	13
Totals		226	32	16	258
		Section 7 (Sawed)			
16+50	16+75	0	0	0	0
16+75	17+00	9	22	0	31
17+00	17+25	18	19	0	37
17+25	17+50	9	14	0	23
17+50	17+75	26	0	0	26
17+75	18+00	14	5	0	19
18+00	18+25	13	0	0	13
18+25	18+50	15	0	0	15
18+50	18+75	25	0	0	25
18+75	19+00	0	0	0	0
19+00	19+25	2	0	0	2
Totals		131	60	0	191
		Section 8 (Fabric)			
19+25	19+50	66	92	0	158
19+50	19+75	71	101	0	172
19+75	20+00	123	84	0	207
20+00	20+25	54	91	34	145
20+25	20+50	113	80	61	193
20+50	20+75	124	67	75	191
20+75	21+00	101	89	64	190
21+00	21+25	82	98	52	180
21+25	21+50	147	107	87	254
21+50	21+75	65	105	45	170
21+75	22+00	60	114	49	174
Totals		1,006	1,028	467	2,034

TABLE 3. SUMMARY OF CRACKING SURVEY 3 FOR PCC BASE SECTIONS (CONTINUED).

STATION FROM	STATION TO	REFLECTIVE CRACKING (LF)	PAVING JOINT CRACKING (LF)	REFLECTIVE CRACKING IN PATCHED AREAS (LF)	TOTAL CRACKING (LF)
		Section 9 (Rubber Filled AC)			
22+00	22+25	162	25	0	187
22+25	22+50	131	25	0	156
22+50	22+75	137	0	0	137
22+75	23+00	128	0	0	128
23+00	23+25	146	25	0	171
23+25	23+50	100	0	0	100
23+50	23+75	115	25	0	140
23+75	24+00	122	25	0	147
24+00	24+25	91	0	0	91
24+25	24+50	155	0	0	155
24+50	24+75	130	18	0	148
Totals		1,417	143	0	1,560
		Section 10 (Asphalt-Rubber)			
24+75	25+00	8	98	0	106
25+00	25+25	36	112	0	148
25+25	25+50	99	118	0	217
25+50	25+75	6	104	0	110
25+75	26+00	65	125	0	190
26+00	26+25	41	125	0	166
26+25	26+50	24	119	0	143
26+50	26+75	57	125	0	182
26+75	27+00	77	121	0	198
27+00	27+25	22	125	0	147
27+25	27+50	50	120	0	170
Totals		485	1,292	0	1,777
		Section 11 (Control)			
27+50	27+75	53	76	0	129
27+75	28+00	38	54	0	92
28+00	28+25	32	61	0	93
28+25	28+50	78	52	0	130
28+50	28+75	34	59	0	93
28+75	29+00	49	67	0	116
29+00	29+25	46	66	0	112
29+25	29+50	66	64	0	130
29+50	29+75	36	72	0	108

TABLE 3. SUMMARY OF CRACKING SURVEY 3 FOR PCC BASE SECTIONS (CONCLUDED).

STATION FROM	STATION TO	REFLECTIVE CRACKING (LF)	PAVING JOINT CRACKING (LF)	REFLECTIVE CRACKING IN PATCHED AREAS (LF)	TOTAL CRACKING (LF)
		Section 11 (Control) (Continued)			
29+75	30+00	62	72	0	134
30+00	30+25	12	62	0	74
Totals		506	705	0	1,211
		Section 12 (Modified Asphalt-Rubber)			
30+25	30+50	58	109	0	167
30+50	30+75	70	125	0	195
30+75	31+00	33	98	0	131
31+00	31+25	57	100	0	157
31+25	31+50	37	110	0	147
31+50	31+75	11	125	0	136
31+75	32+00	66	105	0	171
32+00	32+25	74	125	18	199
32+25	32+50	23	125	6	148
32+50	32+75	77	125	29	202
32+75	33+00	25	125	5	150
Totals		531	1,272	58	1,803

TABLE 4. SURVEY 3 CRACKING RELATIVE TO PRECONSTRUCTION CRACKING FOR PCC BASE SECTIONS.

SECTION	TOTAL REFLECTIVE CRACKING IN SURVEY 3[a] (LF)	ADJUSTED PRECONSTRUCTION CRACKING (LF)	CRACKING RELATIVE TO PRECONSTRUCTION CRACKING PERCENT
1 (A-R)	734	3,417	21.5
2 (Mod. A-R)	927	2,696	34.4
3 (Fabric)	574	992	57.9
4 (Control)	735	3,611	20.4
5 (RFAC)	1,040	3,212	32.4
6 (Saw)	210	2,933	7.2
7 (Saw)	131	2,768	4.7
8 (Fabric)	539	1,964	27.4
9 (RFAC)	1,417	2,935	48.3
10 (A-R)	485	2,561	18.9
11 (Control)	506	2,519	20.1
12 (Mod. A-R)	473	1,939	24.4
Mean			26.5
Standard deviation			15.3
Coefficient of variation, percent			57.7

[a]These data do not include the reflective cracking that occurred in the patched areas.

TABLE 5. ANALYSIS OF VARIANCE OF TOTAL CRACKING FOR PCC BASE SECTIONS.

SOURCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F	F(.05)	F(.01)
Section	11	391,574	35,598	42.52	1.79	2.25
Error	120	100,463	837			
Total	131	492,037				

TABLE 6. CONDITION SURVEY RESULTS FOR PCC BASE SECTIONS.

SECTION	PCI NOT INCLUDING AC PAVING JOINT CRACKS	PCI INCLUDING AC PAVING JOINT CRACKS
1 (A-R)	91	86
2 (Mod. A-R)	86	83
3 (Fabric)	88	79
4 (Control)	90	77
5 (RFAC)	89	85
6 (Saw)	94	93
7 (Saw)	94	93
8 (Fabric)	88	79
9 (RFAC)	88	88
10 (A-R)	90	78
11 (Control)	86	83
12 (Mod. A-R)	89	76

TABLE 7. CRACKING AS A FUNCTION OF THICKNESS FOR PCC BASE SECTIONS.

SECTION	CRACKING IN THICK PAVEMENT (LF)	CRACKING IN THIN PAVEMENT (LF)	CRACKING IN THICK PAVEMENT, PERCENT OF TOTAL CRACKING
1 (A-R)	278	456	37.9
2 (Mod. A-R)	461	559	45.2
3 (Fabric)	368	392	48.4
4 (Control)	239	496	32.5
5 (RFAC)	499	533	48.0
6 (Saw)	13	213	5.8
7 (Saw)	8	123	6.1
8 (Fabric)	178	832	17.6
9 (RFAC)	393	1,024	27.7
10 (Fabric)	125	360	25.8
11 (Control)	239	267	47.2
12 (Mod. A-R)	166	365	31.3

TABLE 8. SUMMARY OF CRACKING SURVEY 3 FOR SOIL CEMENT BASE SECTIONS.

STATION FROM	STATION TO	REFLECTIVE CRACKING (LF)	REFLECTIVE CRACKING (SQ FT)	PAVING JOINT CRACKING (LF)	TOTAL CRACKING (LF)
		Section 13 (Asphalt-Rubber)			
33+00	33+25	168	10	115	N/A
33+25	33+50	196	88	100	N/A
33+50	33+75	198	50	125	N/A
33+75	34+00	238	63	125	N/A
34+00	34+25	247	0	129	N/A
34+25	34+50	213	0	125	N/A
Totals		1,260	211	719	N/A
		Section 14 (Control)			
34+50	34+75	271	30	113	N/A
34+75	35+00	239	23	116	N/A
35+00	35+25	217	0	122	N/A
35+25	35+50	284	0	125	N/A
35+50	35+85	420	0	168	N/A
Totals		1,431	53	644	N/A
		Section 15 (Rubber Filled AC)			
35+85	36+10	254	0	0	254
36+10	36+35	237	0	0	237
36+35	36+60	205	0	0	205
36+60	36+85	180	0	0	180
36+85	37+20	205	0	0	205
Totals		1,081	0	0	1,081
		Section 16 (Fabric)			
37+20	37+45	109	0	77	186
37+45	37+70	195	0	56	251
37+70	37+95	197	0	74	271
37+95	38+30	182	0	68	250
Totals		683	0	275	958

TABLE 8. SUMMARY OF CRACKING SURVEY 3 FOR SOIL CEMENT BASE SECTIONS (CONTINUED).

STATION FROM	STATION TO	REFLECTIVE CRACKING (LF)	REFLECTIVE CRACKING (SQ FT)	PAVING JOINT CRACKING (LF)	TOTAL CRACKING (LF)
Section 17 (Modified Asphalt-Rubber)					
38+30	38+55	174	0	50	N/A
38+55	38+80	294	0	50	N/A
38+80	39+05	277	0	50	N/A
39+05	39+30	250	0	45	N/A
39+30	39+65	349	40	70	N/A
Totals		1,344	40	265	N/A
Section 18 (Asphalt-Rubber)					
39+65	39+90	279	0	50	329
39+90	40+15	175	0	50	225
40+15	40+40	177	0	50	227
40+40	40+65	237	0	50	287
40+65	41+00	258	0	70	328
Totals		1,126	0	270	1,396
Section 19 (Control)					
41+00	41+25	216	56	50	N/A
41+25	41+50	223	93	50	N/A
41+50	41+75	213	84	50	N/A
41+75	42+00	218	86	50	N/A
42+00	42+35	226	237	70	N/A
Totals		1,096	556	270	N/A
Section 20 (Fabric)					
42+35	42+60	264	87	50	N/A
42+60	42+85	248	0	50	N/A
42+85	43+10	225	0	57	N/A
43+10	43+35	148	17	77	N/A
43+35	43+70	324	54	70	N/A
Totals		1,209	158	304	N/A
Section 21 (Modified Asphalt-Rubber)					
43+70	43+95	163	0	75	N/A
43+95	44+20	100	0	62	N/A

TABLE 8. SUMMARY OF CRACKING SURVEY 3 FOR SOIL CEMENT BASE SECTIONS (CONCLUDED).

STATION FROM	STATION TO	REFLECTIVE CRACKING (LF)	REFLECTIVE CRACKING (SQ FT)	PAVING JOINT CRACKING (LF)	TOTAL CRACKING (LF)
Section 21 (Modified Asphalt-Rubber) (Continued)					
44+20	44+45	234	0	50	N/A
44+45	44+70	268	0	50	N/A
44+70	45+05	212	105	70	N/A
45+05	45+31	203	0	52	N/A
Totals		1,180	105	359	N/A
Section 22 (Rubber Filled AC)					
45+31	45+56	238	0	0	238
45+56	45+81	272	0	0	272
45+81	46+06	324	0	0	324
46+06	46+31	204	0	0	204
46+31	46+57	130	0	0	130
Totals		1,168	0	0	1,168

TABLE 9. DATA TO CORRELATE SQUARE FEET OF CRACKING TO LINEAR FEET OF CRACKING FOR SOIL CEMENT BASE SECTIONS.

MEASURED CRACKING (LF)	MEASURED CRACKING (SQ FT)	RATIO OF LINEAR FEET TO SQUARE FEET
35	10	3.50
86	63	1.37
42	25	1.68
125	50	2.50
82	63	1.30
57	30	1.90
74	23	3.22
58	40	1.45
65	26	2.50
20	30	0.67
103	75	1.37
18	9	2.00
41	36	1.14
Mean		1.89
Standard of deviation		0.83
Coefficient of variation		44.00

TABLE 10. SURVEY 3 LINEAR CRACKING RELATIVE TO PRECONSTRUCTION CRACKING FOR SOIL CEMENT BASE SECTIONS.

SECTION	TOTAL CRACKING (LF)	NORMALIZED CRACKING (LF)	NORMALIZED PRECONSTRUCTION CRACKING (SQ FT)	RATIO OF CRACKING TO PRECONSTRUCTION CRACKING LF/SQ FT x 100
13 (A-R)	920	828	4,513	18.3
14 (Control)	886	886	6,000	14.8
15 (RFAC)	1,081	1,081	6,205	17.4
16 (Fabric)	683	838	6,216	13.5
17 (Mod. A-R)	1,414	1,414	6,080	23.3
18 (A-R)	1,126	1,126	6,495	17.3
18 (Control)	2,069	2,069	6,755	30.6
20 (Fabric)	1,476	1,476	6,445	22.9
21 (Mod. A-R)	1,364	1,144	5,856	19.5
22 (RFAC)	1,168	1,251	4,773	26.2
Mean		1,211		20.4
Standard deviation		376		5.3
Coefficient of variation, percent		31.0		26.1

TABLE 11. ANALYSES OF VARIANCE OF TOTAL CRACKING FOR SOIL CEMENT BASE SECTIONS.

SOURCE	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F	F(.05)	F(.01)
Section	9	680.5	75.6	6.06	2.12	2.89
Error	40	499.3	12.5	--	--	--
Total	49	1,179.8	--	--	--	--

TABLE 12. CONDITION SURVEY RESULTS FOR SOIL CEMENT BASE SECTIONS.

SECTION	PCI NOT INCLUDING AC PAVING JOINTS	PCI INCLUDING AC PAVING JOINTS
13 (A-R)	84	68
14 (Control)	80	65
15 (RFAC)	75	75
16 (Fabric)	76	68
17 (Mod. A-R)	71	65
18 (A-R)	69	63
19 (Control)	69	61
20 (Fabric)	68	62
21 (Mod. A-R)	76	68
22 (RFAC)	74	74

TABLE 13. CRACKING AS A FUNCTION OF AC OVERLAY THICKNESS FOR SOIL CEMENT BASE SECTIONS.

SECTION	CRACKING IN THICK PAVEMENT (LF)	CRACKING IN THIN PAVEMENT (LF)	CRACKING IN THICK PAVEMENT, PERCENT OF TOTAL CRACKING
13 (A-R)	552	367	60.1
14 (Control)	476	409	53.8
15 (RFAC)	516	565	47.7
16 (Fabric)	401	282	58.7
17 (Mod. A-R)	914	500	64.6
18 (A-R)	673	453	59.8
19 (Control)	1,329	740	64.2
20 (Fabric)	737	739	49.9
21 (Mod. A-R)	826	538	60.6
22 (RFAC)	433	735	37.1

TABLE 14. PRECONSTRUCTION CRACKING, MAXWELL AFB SECTIONS.

SECTION	CRACKING (LF)	PCI
1	1,875	52
2	1,610	64
3	1,905	46
4	1,620	46
5	1,750	46
6	1,690	46
7	1,400	46

* U. S. GOVERNMENT PRINTING OFFICE: 1989 -635-515/ 30015